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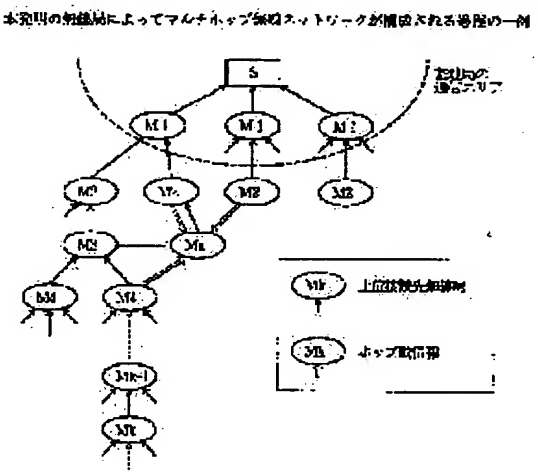
(54) MULTI-HOP RADIO NETWORK AND RADIO STATION

(57)Abstract:
PROBLEM TO BE SOLVED: To allow each radio station to autonomously construct a start type multi-hop radio network by finding the optimal destination of connection (high order connection destination radio station).
SOLUTION: The number of hop information obtaining means for each radio station obtains the number of hop information from a connectable radio station, and when direct connection to a base station is available, a high order connection destination radio station selecting means selects the base station as a high order connection destination radio station. In other cases, selects one connectable radio station whose number of hops obtained from the number of hop information can be made the minimum as the high order connection destination radio station from among the connectable radio stations. Then, a signal transferring means transfers a transmission signal or a signal received from a slave radio station to the high order connection destination radio station, or when direct connection to the base station is available, transfers the signal to the base station.



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CLAIMS

[Claim(s)]
[Claim 1] In the multi-hop wireless network which it consists of a base station and two or more radio stations, each radio station has a junction function, and the radio station which exists outside the communications area of a base station relays a predetermined radio station, and communicates with a base station A number information acquisition means of hop to acquire the number information of hop about the number of junction radio stations (henceforth "the number of hop") from other radio stations (henceforth "a connectable radio station") which can carry out direct continuation of said each radio station to said base station, When direct continuation can be carried out to said base station, a base station is selected as a high order connection place radio station. A high order connection place radio station selection means to select one connectable radio station where the number of hop obtained using said number information of hop serves as min as a high order connection place radio station from said connectable radio stations when direct continuation cannot be carried out to said base station, The signal which received the sending signal or the self-radio station from the high order connection place radio station and the selected low-ranking radio station (henceforth a "child radio station") to said high order connection place radio station Or it is the multi-hop wireless network characterized by being the configuration of having a signal transfer means to transmit to a base station when direct continuation can be carried out to said base station, and said each radio station selecting said high order connection place radio station autonomously, and setting up the junction way to said base station.
[Claim 2] The number information acquisition means of hop of said base station and the radio station which can carry out direct continuation The number of hop of a self-radio station is recognized to be 1. The other number information acquisition means of hop of a radio station What added 1 to the number of hop of the high order connection place radio station which said high order connection place radio station selection means selected is recognized as the number of hop of a self-radio station. The multi-hop wireless network according to claim 1 characterized by being the configuration of adding the number of hop of each radio station in order along said junction way from said base station side.
[Claim 3] The number information acquisition means of hop of said radio station is a multi-hop wireless network according to claim 1 or 2 characterized by being the configuration which receives this information message and acquires the number information of hop on said connectable radio station while always transmitting the information message which contains the number of hop of a self-radio station as said number information of hop in multiple address.
[Claim 4] The number information acquisition means of hop of said radio station is a multi-hop wireless network according to claim 1 or 2 characterized by being the configuration which acquires the number information of hop on said connectable radio station by the receiving timing of this information message while transmitting an information message in multiple address as said number information of hop by the transmit timing based on the number of hop of a self-radio station.
[Claim 5] The number information acquisition means of hop of said radio station transmits the signal required as notifying the number information of hop to said connectable radio station. It transmits to the connectable radio station which required the signal with which the connectable radio station which received this demand signal answers the number information of hop on a self-radio station. The multi-hop wireless network according to claim 1 or 2 characterized by being the configuration in which the radio station which received this reply signal acquires the number information of hop on a connectable radio station.
[Claim 6] The number information acquisition means of hop of the radio station which newly enters into a network [whether said information message from said connectable radio station is received, and the number information of hop is acquired, and] [whether the number information of hop is acquired by the receiving timing of said information message from said connectable radio station, and] The multi-hop wireless network according to claim 3 to 5 characterized by being the configuration which transmits a demand signal to said connectable radio station, receives the reply signal according to it, and acquires the number information of hop.
[Claim 7] The number information acquisition means of hop of said radio station, and a high order connection place radio station selection means After building a multi-hop wireless network, one connectable radio station

where said number of hop serves as min out of said connectable radio station to predetermined timing is selected. The multi-hop wireless network according to claim 1 to 6 characterized by being the configuration which selects the connectable radio station as a new high order connection place radio station when the connectable radio station and the present high order connection place radio station are inequalities.
[Claim 8] The number information acquisition means of hop of said radio station, and a high order connection place radio station selection means When said high order connection place radio station and connection become impossible after building a multi-hop wireless network The multi-hop wireless network according to claim 1 to 6 characterized by being the configuration which selects one connectable radio station where said number of hop serves as min except for said child radio station out of said connectable radio station anew as a high order connection place radio station.
[Claim 9] The number information acquisition means of hop of said radio station, and a high order connection place radio station selection means When said high order connection place radio station and connection become impossible after building a multi-hop wireless network A connection improper signal reports that to said child radio station, and one connectable radio station where said number of hop serves as min out of said connectable radio station anew after information is selected as a high order connection place radio station. Moreover, the radio station which received said connection improper signal from said high order connection place radio station is a multi-hop wireless network according to claim 1 to 6 characterized by being the configuration which selects a new high order connection place radio station while reporting a connection improper signal to a child radio station similarly.
[Claim 10] In the radio station of the multi-hop wireless network which it consists of a base station and two or more radio stations, each radio station has a junction function, and the radio station which exists outside the communications area of a base station relays a predetermined radio station, and communicates with a base station A number information acquisition means of hop to acquire the number information of hop about said number of hop from said connectable radio station, When direct continuation can be carried out to said base station, a base station is selected as a high order connection place radio station. A high order connection place radio station selection means to select one connectable radio station where the number of hop obtained using said number information of hop serves as min as a high order connection place radio station from said connectable radio stations when direct continuation cannot be carried out to said base station, It is the radio station of the multi-hop wireless network characterized by having a signal transfer means to transmit to a base station when the direct continuation of the signal received from the sending signal or said child radio station can be carried out to said high order connection place radio station or said base station.
[Claim 11] It is the radio station of the multi-hop wireless network according to claim 10 which the number information acquisition means of hop of said base station and the radio station which can carry out direct continuation recognizes the number of a self-radio station of hop to be 1, and is characterized by for the other number information acquisition means of hop of a radio station to be the configuration of recognizing what added 1 to the number of hop of the high order connection place radio station which said high order connection place radio station selection means selected to be the number of hop of a self-radio station.
[Claim 12] Said number information acquisition means of hop is the radio station of the multi-hop wireless network according to claim 10 or 11 characterized by being the configuration which receives this information message and acquires the number information of hop on said connectable radio station while always transmitting the information message which contains the number of hop of a self-radio station as said number information of hop in multiple address.
[Claim 13] Said number information acquisition means of hop is the radio station of the multi-hop wireless network according to claim 10 or 11 characterized by being the configuration which acquires the number information of hop on said connectable radio station by the receiving timing of this information message while transmitting an information message in multiple address as said number information of hop by the transmit timing based on the number of hop of a self-radio station.
[Claim 14] Said number information acquisition means of hop transmits the signal required as notifying the number information of hop to said connectable radio station. It transmits to the connectable radio station which required the signal with which the connectable radio station which received this demand signal answers the number information of hop on a self-radio station. The radio station of the multi-hop wireless network according to claim 10 or 11 characterized by being the configuration in which the radio station which received this reply signal acquires the number information of hop on a connectable radio station.
[Claim 15] The number information acquisition means of hop of the radio station which newly enters into a network [whether said information message from said connectable radio station is received, and the number information of hop is acquired, and] [whether the number information of hop is acquired by the receiving timing of said information message from said connectable radio station, and] The radio station of the multi-hop wireless network according to claim 12 to 14 characterized by being the configuration which transmits a demand signal to said connectable radio station, receives the reply signal according to it, and acquires the number information of hop.

[Claim 16] Said number information acquisition means of hop, and a high order connection place radio station selection means After building a multi-hop wireless network, one connectable radio station where said number of hop serves as min out of said connectable radio station to predetermined timing is selected. The radio station of the multi-hop wireless network according to claim 10 to 15 characterized by being the configuration which selects the connectable radio station as a new high order connection place radio station when the connectable radio station and the present high order connection place radio station are inequalities.
[Claim 17] Said number information acquisition means of hop, and a high order connection place radio station selection means When said high order connection place radio station and connection become impossible after building a multi-hop wireless network The radio station of the multi-hop wireless network according to claim 10 to 15 characterized by being the configuration which selects one connectable radio station where said number of hop serves as min except for said child radio station out of said connectable radio station anew as a high order connection place radio station.
[Claim 18] Said number information acquisition means of hop, and a high order connection place radio station selection means When said high order connection place radio station and connection become impossible after building a multi-hop wireless network A connection improper signal reports that to said child radio station, and one connectable radio station where said number of hop serves as min out of said connectable radio station anew after information is selected as a high order connection place radio station. The radio station which received said connection improper signal from said high order connection place radio station again is a radio station of the multi-hop wireless network according to claim 10 to 15 characterized by being the configuration which selects a new high order connection place radio station while reporting a connection improper signal to a child radio station similarly.

[Translation done.]

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention relates to the multi-hop wireless network which can relay each radio station also from the radio station which exists outside the communications area of a base station when each radio station has a junction function, and can access a base station in the star mold wireless network where two or more radio stations like mobile communications or wireless LAN access the same base station.
[0002] It is related with the multi-hop wireless network and radio station which build autonomously the junction way from each radio station to a base station especially.
[0003]
[Description of the Prior Art] In mobile communications, such as PDC and PHS, each radio station once accesses the base station by which direct continuation is carried out to the communication network, in order to access a communication network. These systems take the configuration of the star mold wireless network where two or more radio stations access the same base station, and the communications area of each base station turns into area of the system concerned which can be communication service offered as it is.
[0004] Here, in the case of PDC, since the communications area of a base station attains to the radius of several km, communication service can be offered broadly in few base stations, but in the case of PHS, since the communications area of a base station remains in hundreds of m, in order to offer wide range communication service, it is necessary to arrange many base stations. Moreover, the demand of improvement in the speed of transmission speed follows on rising, use of the base station where mobile communications also use high-frequency bands, such as wireless LAN, can be considered, and transceiver area may become narrow further rather than the base station of PHS from now on.
[0005] Thus, in a system with the small communications area of a base station, there is the approach of constituting a multi-hop wireless network between radio stations as the one technique of extending service provision area. A multi-hop wireless network is the network gestalt with which between the radio station can communicate, when each radio station has a junction function and two or more radio stations which exist between them between the radio stations whose direct communication is mutually impossible relay a signal.
[0006] When this multi-hop wireless network is applied to the above-mentioned star mold wireless network, For example, if the radio station (henceforth a "junction radio station") of near with a junction function receives the signal transmitted from the radio station (henceforth "the radio station outside area") which is outside the communications area of a certain base station This junction radio station transmits the received signal to the junction radio station more near a base station (henceforth a "high order"), and this junction radio station transmits the received signal to the junction radio station of a high order further, and transmits it to a base station through the junction radio station of a high order one by one below. Thereby, a base station can receive the signal transmitted from the radio station outside area. Moreover, the signal transmitted from a base station can also follow a path completely contrary to the above, and can receive the radio station outside area.
[0007] Therefore, the radio station which is outside the communications area of a base station becomes possible [communicating with a base station] by constituting a multi-hop wireless network between each radio station. Thereby, even if the communications area of a base station like wireless LAN is a narrow system, it becomes possible to extend the service provision area of a base station autonomously between radio stations.
[0008] In the general multi-hop wireless network, in order to send the signal from the radio station of arbitration to the radio station of a transmission place, the junction way needs to be established between the transmitting agency radio station and the transmission place radio station. However, in the above-mentioned star mold wireless network, since the transmission place of the signal transmitted from each radio station is surely a base station, each radio station has just established the junction way to a base station. That is, since the number of the junction ways which each radio station establishes is one, it is enough if one high order connection place radio station (a junction radio station, base station) where each radio station carries out the junction transfer of the signal is appointed. If in other words each radio station sets a high order connection place radio station to a meaning, the signal from the radio station of arbitration will be transmitted to a base station, when each radio

station transmits to a high order connection place radio station.
[0009] Therefore, what is necessary is just to build the structure (henceforth a "star mold multi-hop wireless network") where a base station is made into the top station between base station-radio stations, and each radio station sets a high order connection place radio station to a meaning, in order to apply a multi-hop wireless network to the above-mentioned star mold wireless network. Here, the example of a configuration of the star mold multi-hop wireless network which makes a base station the top office is shown in drawing 1 R> 1. In drawing, S is a base station, M is a radio station, and an arrow head shows a high order connection place radio station.
[0010] There is what [centralized-control-/ a thing] that is depended on the top station as a method of building the conventional star mold multi-hop wireless network. This is the building method for each radio station notifying all other radio stations connectable from a local station to the top station, grasping all the star mold multi-hop wireless network configuration that can realize the top station, choosing the optimal star mold multi-hop wireless network configuration out of it, and directing a connection place to each radio station.
[0011]
[Problem(s) to be Solved by the Invention] Reconstruction is needed when it becomes impossible, as for such a centralized control building method, for a certain radio station to bear a junction function according to causes, such as failure and migration. In order that the top office may grasp the purport to which it became impossible for the radio station where it broke down and moved to bear a junction function in this, that radio station and the connected radio station notify that to the top office one after another first, and the top office must appoint the optimal connection place radio station of each radio station anew followed on reconstruction of a star mold multi-hop wireless network in response to this notice, and must report it to all radio stations. Moreover, the same actuation is needed also when a radio station is newly added.
[0012] Therefore, by the centralized control building method, when it became impossible for a certain radio station to act as intermediary according to causes, such as failure and migration, or when a radio station was newly added, the time amount which reconstruction of a star mold multi-hop wireless network takes became long, and there was a problem as for which modification of network configuration is not made immediately. Moreover, there was a problem on which traffic for control, such as change-notice traffic for modification and information traffic, increases.
[0013] All the top offices (base station) do not control construction of a star mold multi-hop wireless network, but this invention aims to let each radio station offer the multi-hop wireless network and radio station which can be built autonomously by finding the radio station of a connection place with each optimal radio station.
[0014]
[Means for Solving the Problem] Invention of a publication shows the method of building a multi-hop wireless network to claims 1 and 2. Namely, the number information acquisition means of hop of each radio station acquires the number information of hop from a connectable radio station. When the direct continuation of the high order connection place radio station selection means can be carried out to a base station, a base station is selected as a high order connection place radio station. When direct continuation cannot be carried out to a base station, one connectable radio station where the number of hop obtained using the number information of hop serves as min is selected as a high order connection place radio station from connectable radio stations. When a signal transfer means can carry out direct continuation of the signal received from the sending signal or the child radio station to a high order connection place radio station or a base station, each radio station can build a multi-hop wireless network autonomously by transmitting to a base station.
[0015] In addition, although this is premised on each radio station recognizing the number of hop of a self-radio station beforehand, when it is undecided, it decides sequentially from the direction near a base station. Namely, the number information acquisition means of the other radio station of hop is decided [by the number information acquisition means of hop of a base station and the radio station which can carry out direct continuation setting up the number of a self-radio station of hop with 1] sequentially from the direction with the number of each radio station which constitutes a multi-hop wireless network near a base station of hop by setting up what added 1 to the number of hop of the high order connection place radio station which the high order connection place radio station selection means selected as the number of hop of a self-radio station. And each radio station can build a multi-hop wireless network autonomously by selecting one high order connection place radio station in each radio station, respectively.
[0016] Invention according to claim 3 to 5 shows the configuration of the number information acquisition means of hop of a radio station. That is, the number information acquisition means of hop of the radio station of claim 3 is a configuration which receives this information message and acquires the number information of hop on a connectable radio station while always transmitting the information message which contains the number of hop of a self-radio station as number information of hop in multiple address.
[0017] The number information acquisition means of hop of the radio station of claim 4 is a configuration which acquires the number information of hop on a connectable radio station by the receiving timing of this information

message while transmitting an information message in multiple address as number information of hop by the transmit timing based on the number of hop of a self-radio station.
[0018] It is the configuration which the radio station which the number information acquisition means of the radio station of claim 5 of hop transmitted the signal which requires as notifying that number information of hop to a connectable radio station, transmitted it to the connectable radio station which required the signal with which the connectable radio station which received this demand signal answers the number information of hop on a self-radio station, and received this reply signal acquires in the number information of hop on a connectable radio station.
[0019] the above -- by any configuration, the number information acquisition means of hop can acquire the number information of hop from a connectable radio station, and if one connectable radio station where the number of hop serves as min from the inside is selected as a high order connection place radio station, a multi-hop wireless network will be built autonomously.
[0020] Invention according to claim 6 shows a configuration in case a new radio station enters into a multi-hop wireless network. [whether the number information acquisition means of hop of the radio station receives the information message from a connectable radio station, and acquires the number information of hop, and] By acquiring the number information of hop by the receiving timing of the information message from a connectable radio station, or transmitting a demand signal to a connectable radio station, receiving the reply signal according to it, and acquiring the number information of hop One connectable radio station where the number of hop serves as min can be selected as a high order connection place radio station, and it can join a multi-hop wireless network.
[0021] Invention according to claim 7 to 9 shows the configuration in the case of reconstructing a multi-hop wireless network. That is, after the number information acquisition means of hop of the radio station of claim 7 and a high order connection place radio station selection means build a multi-hop wireless network, they are the configuration which selects one connectable radio station where the number of hop serves as min out of a connectable radio station to predetermined timing, and selects the connectable radio station as a new high order connection place radio station when the connectable radio station and the present high order connection place radio station are inequalities.
[0022] When connection becomes impossible with a high order connection place radio station after the number information acquisition means of hop of the radio station of claim 8 and a high order connection place radio station selection means build a multi-hop wireless network, they are the configuration which selects one connectable radio station where the number of hop serves as min except for a child radio station out of a connectable radio station anew as a high order connection place radio station.
[0023] The number information acquisition means of hop of the radio station of claim 9, and a high order connection place radio station selection means When connection becomes impossible with a high order connection place radio station after building a multi-hop wireless network A connection improper signal reports that to a child radio station, and one connectable radio station where the number of hop serves as min out of a connectable radio station anew after information is selected as a high order connection place radio station. Moreover, the radio station which received the connection improper signal from the high order connection place radio station is a configuration which selects a new high order connection place radio station while reporting a connection improper signal to a child radio station similarly.
[0024] Invention according to claim 10 to 18 shows the configuration of the radio station corresponding to a multi-hop wireless network according to claim 1 to 9.
[0025]
[Embodiment of the Invention] (Operation gestalt of invention given in claims 1, 2, 10, and 11) Drawing 2 shows the operation gestalt of the radio station which constitutes the multi-hop wireless network of this invention. A radio station is equipped with a number information acquisition means 11 of hop acquire the number information of hop from a connectable radio station, a high order connection place radio station selection means 12 select the high order connection place radio station which serves as a junction place out of a connectable radio station according to this number information of hop, and a signal transfer means 13 transmit the signal which received from the sending signal or the child radio station to a high order connection place radio station or a base station, in drawing.
[0026] Drawing 3 shows the fundamental procedure of the high order connection place radio station selection means 12. First, when the direct continuation of the radio station can be carried out to a base station, a base station is selected as a high order connection place radio station (a1). Next, when direct continuation cannot be carried out to a base station, the number information of hop on the connectable radio station which the number information acquisition means 11 of hop acquired is inputted (a2), and one connectable radio station where the number information of hop on each connectable radio station is compared, and the number of hop serves as min from the inside is selected as a high order connection place radio station (a3). The high order connection place radio station selected here is notified to the signal transfer means 13, and serves as the destination of the signal

received from the child radio station.
[0027] Moreover, if a high order connection place radio station is selected (a3), what added 1 to the number of hop will be recognized as the number of hop of a self-radio station, and the number information of hop will be notified to the number information acquisition means 11 of hop of a connectable radio station (a4). The number information acquisition means 11 of hop notifies the number information of hop to a connectable radio station by the approach explained below. In addition, the number information acquisition means 11 of hop of a base station and the radio station which can carry out direct continuation recognizes the number of hop of a self-radio station to be 1, and the other number information acquisition means 11 of hop of a radio station recognizes what added 1 to the number of hop of the high order connection place radio station which the high order connection place radio station selection means 12 selected as the number of hop of a self-radio station. Moreover, a base station may be treated as one radio station, and the number of hop of a base station may be defined as 0.
[0028] Drawing 4 shows an example of the process in which a multi-hop wireless network is constituted by the radio station of this invention. In drawing, one hop is set to the number information acquisition means 11 of hop of the radio station M1 which can carry out direct continuation to a base station S. Next, if this radio station M1 is decided, when the radio station which makes this a connectable radio station selects one radio station M1 as a high order connection place radio station, respectively, it will be decided to each radio station M1 that the radio station M2 used as two hop will be the shape of a tree. Radio stations M3, M4, --, Mk are decided one by one like the following. Here, Mk shows the radio station whose number of hop is k.
[0029] Now, a radio station Mx presupposes that it has newly entered in a network. A radio station Mx chooses one radio station M2 where the number of hop serves as min out of the radio stations M2, M3, and M4 which are connectable radio stations, and selects this as a high order connection place radio station. By this, the number of hop of a radio station Mx is set to 3, and will be connected to one radio station M2 as a high order connection place radio station. Thus, each radio station appoints only one high order connection place radio station, respectively. Thereby, each radio station is connected to a high order connection place radio station, and the multi-hop wireless network which makes a base station the top station is formed between a base station and each radio station.
[0030] Drawing 5 shows the fundamental procedure of the signal transfer means 13. Drawing 5 (a) It is the procedure of the signal transfer means 13 in a transmitting agency radio station. The signal transfer means 13 in a transmitting agency radio station will transmit the sending signal to a high order connection place radio station, if the sending signal addressed to a base station occurs (b1) (b2). Drawing 5 (b) It is the procedure of the signal transfer means 13 in a junction radio station. The signal transfer means 13 in a junction radio station will transmit the received signal to a high order connection place radio station, if a signal is received from a child radio station (c1) (c2).
[0031] The signal transmitted by actuation of such a signal transfer means 13 of a radio station from the radio station which exists outside the communications area of a base station can also be transmitted to a base station. The situation of this signal transfer is shown in drawing 6 .
[0032] Radio station Mk-1 which is a high order connection place radio station first when the radio station Mk which exists outside the communications area of a base station S transmits a signal to a base station in drawing 6 A signal is transmitted. Radio station Mk-1 which received this signal Radio station Mk-2 which is a high order connection place radio station similarly An input signal is transmitted. Hereafter, each radio station transmits an input signal to a high order connection place radio station, respectively, and, finally a radio station M1 transmits an input signal to a base station S. When transmitting a signal to a radio station Mk from a base station S, it can transmit by following this path conversely.
[0033] With the above procedure, each radio station can select a high order connection place radio station, and the multi-hop wireless network which makes a base station the top office can be built autonomously. Moreover, since each radio station has selected the radio station of the number of the minimum hop from connectable radio stations to the high order connection place radio station, the multi-hop wireless network where the number of hop serves as min is built automatically. Moreover, the junction way to which the signal transmitted from the radio station which exists outside the communications area of a base station is transmitted to a base station through 1 or two or more junction radio stations is automatically establishable by transmitting the signal which each radio station received from the child radio station to a high order connection place radio station.
[0034] (Operation gestalt of invention given in claims 3 and 12) This operation gestalt transmits the information message (henceforth "the number message of hop") in which the number information acquisition means 11 of hop of each radio station included the number of hop of a self-radio station in multiple address, and receives this number message of hop, and acquires the number of hop of a connectable radio station. In addition, when a base station transmits the number message of hop in multiple address similarly, the number of hop of a base station is defined as 0. The carrier for the number messages of hop shall be beforehand defined in this network.
[0035] Drawing 7 shows the 1st operation gestalt of the procedure of the number information acquisition means 11 of hop of a radio station, and the high order connection place radio station selection means 12. In drawing, in

case the number information acquisition means 11 of hop of each radio station tends to acquire the number of hop of a connectable radio station, search-time t of the number message of hop is set up first (d1), and the flag 0 which shows an initial state is set up (d2).
[0036] Next, supervising whether it went through search-time t, the carrier for the number messages of hop is searched (d4), and receiving level judges whether the signal beyond a threshold L was received (d5). (d3) Receiving level restores to this signal, when the signal beyond a threshold L is received, and it judges whether it is the number message of hop (d6). In addition, it is the decision criterion which judges whether this threshold L is connectable with the radio station where a self-radio station transmits this signal, and is the minimum receiving level which specifically chooses a connectable radio station. On the other hand, when receiving level is under the threshold L, it returns to the search (d3, d4) of the carrier for the number messages of hop.
[0037] When an input signal is the number message of hop, the number of hop and the transmitting agency radio station ID are read, and the number of hop of a connectable radio station is acquired (d7). On the other hand, when an input signal is not the number message of hop, it returns to the search (d3, d4) of the carrier for the number messages of hop again. Next, it judges whether it is a flag 0 about whether the number of hop of the acquired connectable radio station is the beginning (d8). Since it is a flag 0 at first, the number of hop of the acquired connectable radio station is memorized (d9), and it is set as a flag 1 (d10), and returns to the search (d3, d4) of the carrier for the number messages of hop again.
[0038] When the following number message of hop is received, it is No with a flag 1d8. It becomes and compares with the number of hop of the already memorized connectable radio station (d11). In being smaller than the number of hop which the number of hop of the newly acquired connectable radio station has memorized, the number of hop of the memorized connectable radio station is eliminated, and it memorizes the number of hop of the newly acquired connectable radio station (d12). It is larger than the number of hop which the number of hop of the connectable radio station newly acquired on the other hand has memorized, or in being equal, the number of hop of the memorized connectable radio station is left as it is, and it returns to the search (d3, d4) of the carrier for the number messages of hop again. In addition, when equal to the number of hop which the number of hop of the newly acquired connectable radio station has memorized, you may change to the number of hop of the newly acquired connectable radio station, receiving level is compared, the larger one is chosen, and you may make it memorize. By this, the minimum thing will always be memorized in the acquired number of hop of a connectable radio station.
[0039] Moreover, although it is always supervising whether search-time t was exceeded from search initiation during the search (d3), when having not gone through search-time t, the search of the carrier for the number messages of hop is continued (d4). On the other hand, when it goes through search-time t, the search of the carrier for the number messages of hop is considered as termination, and it is judged that the number of hop of the connectable radio station memorized at present is min (d13).
[0040] By the above processing, each radio station can recognize the radio station of the number of the minimum hop with the number of hop acquired from the number message of hop of a connectable radio station. And this radio station is selected with a high order connection place radio station (a3 of drawing 3). In the radio station which has selected one high order connection place radio station from connectable radio stations, what added 1 to the number of hop of a high order connection place radio station is made into the number of hop of a self-radio station, and the number message of hop incorporating the number of hop is transmitted in multiple address (a4 of drawing 3).
[0041] (Operation gestalt of invention given in claims 4 and 13) The number information acquisition means 11 of hop of each radio station transmits an information message (henceforth "the number timing message of hop") in multiple address by the transmit timing based on the number of hop of a self-radio station, and this operation gestalt recognizes the number of hop of a connectable radio station by the receiving timing of this number timing message of hop. In addition, when a base station transmits the number timing message of hop in multiple address by predetermined transmit timing similarly, the number of hop of a base station is defined as 0, and the transmit timing according to it is set up. The carrier for the number timing messages of hop shall be beforehand defined in this network.
[0042] Drawing 8 shows an example of the timing to which a base station and each radio station transmit the number timing message of hop. In drawing, the information time zone L, the base station, and each radio station where a base station and each radio station transmit the number timing message of hop are divided into the information time interval D which does not transmit any number timing message of hop, and a time-axis repeats this the information period T. However, it is necessary to take the larger information time interval D than the information time zone L.
[0043] The information time zone L is classified into the class information time zone when the radio station where the number of hop is the same transmits the number timing message of hop. For example, only a base station can transmit the number timing message P0 of hop at the first class information time zone, and only a radio station with one hop can transmit the number timing message P1 of hop, and makes the next class

information time zone like the following 2 and 3 hop and the thing of -- to which only a radio station can transmit the number timing messages P2 and P3 of hop, and -- for every class information time zone, respectively. A base station and each radio station transmit the number timing message of hop to every information period T in the class information time zone corresponding to each number of hop.

[0044] Drawing 9 shows the 2nd operation gestalt of the procedure of the number information acquisition means 11 of hop of a radio station, and the high order connection place radio station selection means 12. In drawing, in case the number information acquisition means 11 of hop of each radio station tends to acquire the number of hop of a connectable radio station, the flag 0 which shows an initial state is set up (f1), and the count N of the confirmation of receipt of the number timing message of hop is set up (f2).

[0045] Next, the carrier for the number timing messages of hop is searched (f3), and receiving level judges whether the signal beyond a threshold L was received (f4). Receiving level restores to this signal, when the signal beyond a threshold L is received, and it judges whether it is the number timing message of hop (f5). In addition, it is the decision criterion which judges whether this threshold L is connectable with the radio station where a self-radio station transmits this signal, and is the minimum receiving level which specifically chooses a connectable radio station. On the other hand, when receiving level is under the threshold L, or when an input signal is not the number timing message of hop, it returns to the search (f3) of the carrier for the number timing messages of hop.

[0046] When an input signal is the number timing message of hop, it judges whether it is a flag 0 (f6). It is the time of day T0 which received the number timing message of hop first since it was a flag 0 at first. It carries out, the present time of day is set up (f7), and the transmitting agency radio station ID is acquired and memorized from the number timing message of hop which received (f8). Next, it is set as n= 1 which shows that it was set as the flag 1 (f9), and the number timing message of hop which received further was first received in the information time zone L, and the number timing message of hop was received for the first time (f10), and returns to the search (f3) of the carrier for the number timing messages of hop again.

[0047] the case where the following number timing message of hop is received -- a flag one f6 -- No The receipt time T0 of the number timing message of hop which became and received previously from -- elapsed time judges whether it is more than the information time zone L (f11). If this elapsed time is not more than L (it is No at f11), the number timing message of hop which received will judge that it is not what received first in the information time zone L, will disregard that reception, and will return to the search (f3) of the carrier for the number timing messages of hop again. on the other hand -- the previous receipt time T0 from -- with [elapsed time] L [more than] (it is Yes at f11), the number timing message of hop which received judges that it is the first reception in the information time zone L, and performs the following processings.

[0048] First, time of day T0 The transmitting agency radio station ID is acquired from the number timing message of hop which reset at current time (f12) and received (f13), and it judges whether the transmitting agency radio station ID remembered to be the this transmitting former radio station ID is in agreement (f14). When both are in agreement, the number timing message of hop which received judges whether since it means that it is received first and the further last number timing message of hop was again received also this information period in the information time zone L, 1 was added to n (f15) and n became the count N of a check (f16). If n has not become the count N of a check, it returns to the search (f3) of the carrier for the number timing messages of hop again. On the other hand, if n has become the count N of a check, it will be decided that the number timing message of hop which received is first received in the information time zone L, and it will recognize that the memorized transmitting agency radio station ID is a radio station of the number of the minimum hop in a connectable radio station (f17).

[0049] Moreover, when the transmitting agency radio station ID remembered to be the transmitting agency radio station ID is an inequality, it can be recognized as what was received to different timing from the number timing message of hop by which No) and the number timing message of hop which received were first received in the last information time zone L (f14 unlike the last thing. Therefore, the memorized transmitting agency radio station ID is eliminated, and the transmitting agency radio station ID read in the number timing message of hop which received now is newly memorized (f18). Then, it initializes to n= 1 (f19), and returns to the search (f3) of the carrier for the number timing messages of hop again.

[0050] Drawing 10 shows the concrete example of the 2nd operation gestalt of operation. It sets to drawing and is the first information period Ta. Although the number timing messages P3 and P4 of hop are continuously received to the timing then corresponding to 3 and 4 hop, P3 receives first in the information time zone L, and memorizes the connectable radio station as a radio station of the number of the minimum hop (f8). P4 [and] received continuously -- the receipt time T0 of P3 from -- since it is less than the information time zone L, it is ignored (it is No at f11).

[0051] next, the receipt time T0 of P3 from -- the number timing message of hop received above the information time zone L is supervised. Namely, the following information period Tb Since it supervises whether the number timing message of hop is received and the number timing message P2 of hop corresponding to two

hop is received here, the connectable radio station is memorized as a radio station of the number of the minimum hop (being f11 Yes, f18). Information period Tb P3 and P4 which can be set are disregarded (being f11 No).

[0052] next, the receipt time T0 of P2 from -- the number timing message of hop received above the information time zone L is supervised. Namely, the following information period Tc It supervises whether the number timing message of hop is received, and P2 is received again here (it is Yes and f14 in f11, and is Yes). When N time reception of these P2 is carried out similarly, the connectable radio station which transmitted P2 is decided as a radio station of the number of the minimum hop (f17).

[0053] By the above processing, each radio station can supervise the receiving timing of the number timing message of hop, and the radio station first transmitted in the information time zone L out of the connectable radio station, i.e., the number of hop, can recognize the minimum radio station. Moreover, the radio station which transmitted the number timing message of hop first can be checked over multiple times by preparing the count of a check in an information time zone. And this radio station is selected with a high order connection place radio station (a3 of drawing 3).

[0054] In the radio station which has selected one high order connection place radio station from connectable radio stations, what added 1 to the number of hop of a high order connection place radio station is made into the number of hop of a self-radio station, and the number timing message of hop is transmitted in multiple address by the transmit timing corresponding to the number of hop (a4 of drawing 3). This concrete procedure is explained with reference to drawing 11 .

[0055] In drawing 11 , each radio station's selection of a high order connection place radio station judges in the class information time zone of what position the high order connection place radio station has transmitted the number timing message of hop based on the conventional time O (g2). (g1) If each radio station recognizes beforehand the time amount length of a class information time zone, this decision is possible when the time amount which received the number timing message of hop from a high order connection place radio station calculates what time of that time amount length it is by measuring from the conventional time O. If the class information time zone when the high order connection place radio station has transmitted the number timing message of hop is known, the number timing message of hop of a self-radio station will be transmitted in the next class information time zone (g3).

[0056] In addition, when there are two or more radio stations which transmit the number timing message of hop in the same class information time zone, the number timing message of hop of a self-radio station is transmitted to the timing which is not transmitted from other radio stations by carrier sense etc. Thereby, each radio station can transmit the number timing message of hop by the transmit timing (class information time zone) corresponding to the number of hop, and can notify the information which is equivalent to the number of hop to a connectable radio station.

[0057] Each radio station only adjusts the transmit timing of an information message, out of a connectable radio station, each radio station recognizes the radio station of the number of the minimum hop, and this operation gestalt can carry out the thing of it. Therefore, even when the number of hop cannot be incorporated into an information message, if each radio station is the communication system which can recognize the conventional time O of an information message, it can apply. For example, it is applicable to the communication system which has taken the synchronization of each radio station by the existing information message beforehand like PHS.

[0058] (Operation gestalt of invention given in claims 5 and 14) This operation gestalt the number information acquisition means 11 of hop of each radio station -- a connectable radio station -- the number information of hop (the number message of hop --) The signal required as notifying the number timing message of hop is transmitted. It transmits to the connectable radio station which required the signal with which the connectable radio station which received this demand signal answers the number information of hop on a self-radio station, and the radio station which received this reply signal acquires the number information of hop on a connectable radio station.

[0059] Drawing 12 shows the 3rd operation gestalt of the procedure of the number information acquisition means 11 of hop of the radio station of this invention, and the high order connection place radio station selection means 12. In drawing, in case the number information acquisition means 11 of hop of each radio station tends to acquire the number information of hop on a connectable radio station, the number information-requirements signal of hop is first transmitted in multiple address towards a circumference radio station (h1). The circumference radio station which received this number information-requirements signal of hop judges whether receiving level is received above a threshold L (i1). The radio station where receiving level received the number information-requirements signal of hop above the threshold L turns into a connectable radio station to a transmitting agency radio station (i2). In addition, it is the decision criterion which judges whether this threshold L is connectable with the radio station where a self-radio station transmits this signal, and is the minimum receiving level which specifically chooses a connectable radio station.

[0060] The number information acquisition means 11 of hop of a connectable radio station transmits the reply

signal which notifies the number information of hop on a self-radio station to a transmitting agency radio station (i3).-In addition, the number message of hop incorporating the number of hop is sufficient as this reply signal, and the number timing message of hop transmitted by the transmit timing corresponding to the number of hop is sufficient as it.

[0061] A number information acquisition means 11 of hop of a radio station by which the number information-requirements signal of hop was transmitted recognizes the radio station of the number of the minimum hop out of a connectable radio station by receiving this reply signal by the configuration shown in the operation gestalt of the above 1st, or the 2nd operation gestalt (h2).

[0062] By the above processing, each radio station can recognize the radio station of min [number / of hop] out of a connectable radio station. And this radio station is selected with a high order connection place radio station (a3 of drawing 3). In the radio station which has selected one high order connection place radio station from connectable radio stations, what added 1 to the number of hop of a high order connection place radio station is recognized as the number of hop of a self-radio station, and a connectable radio station answers the number information of hop in multiple address according to the number information-requirements signal of hop (a4 of drawing 3).

[0063] With this operation gestalt, only when each radio station receives the number information-requirements signal of hop, the message which tells the number of hop is transmitted. Therefore, since it is not necessary to transmit the signal which tells the number information of hop always in multiple address like the operation gestalt of the above 1st, or the 2nd operation gestalt, it becomes possible to stop traffic.

[0064] The new radio station which newly entered in the multi-hop wireless network can apply the operation gestalt of the procedure of the number information acquisition means 11 of hop of the radio station shown above, and the high order connection place radio station selection means 12, in case it is going to acquire the number information of hop on a connectable radio station (claims 6 and 15). Thereby, the high order connection place radio station to a new radio station is decided, and entry to a multi-hop wireless network is attained. Moreover, after building a multi-hop wireless network, in case each radio station tends to acquire the number information of hop on a connectable radio station to predetermined timing, you may apply. This becomes reconstructible [a multi-hop wireless network]. Hereafter, the characteristic procedure in reconstruction of a multi-hop wireless network is explained.

[0065] (Operation gestalt of invention given in claims 7 and 16) Drawing 13 shows the 4th operation gestalt of the procedure of the number information acquisition means 11 of hop of the radio station of this invention, and the high order connection place radio station selection means 12. The number of hop out of a connectable radio station considers as the time amount the radio station where the number information acquisition means 11 of (j1) hop serves as min is again recognized to be after each radio station selects a high order connection place radio station in drawing, and it is the search stop time Ts. It sets up (j2). Next, search stop time Ts Progress recognizes again the radio station where the number of hop serves as min out of a connectable radio station (j4). (j3) And the radio station of the number of the minimum hop which it had a new appreciation of judges whether it is in agreement with a current high order connection place radio station (j5). When both are in agreement, a high order connection place radio station is not changed, but it is the search stop time Ts again. It returns to a setup (j2).

[0066] On the other hand, when the radio station of the number of the minimum hop which it had a new appreciation of, and the present high order connection place radio station are inequalities, it means that the connectable radio station with few hop than a high order connection place radio station had appeared, and changes to the radio station of the number of the minimum hop which had a new appreciation of a high order connection place radio station have (j6).

[0067] in addition, the approach of having a new appreciation of the radio station of the number of the minimum hop out of a connectable radio station -- operation gestalt [of the above 1st] - the procedure shown in the 3rd operation gestalt is adopted. Moreover, when the procedure shown in the operation gestalt of the above 1st or the 3rd operation gestalt is adopted, the number of hop of the radio station of the number of the minimum hop which it had a new appreciation of is compared with the number of hop of a current high order connection place radio station, and when the former is small, you may change to the radio station of the number of the minimum hop which had a new appreciation of a high order connection place radio station have.

[0068] By the above processing, each radio station can always select the radio station of the number of the minimum hop in a connectable radio station as a high order connection place radio station. Therefore, when a new radio station enters in this network, when the number of hop of a new radio station is smaller than the number of hop of the high order connection place radio station of a self-radio station, this radio station can change a high order connection place radio station to a new radio station autonomously temporarily. thus, the case where a new radio station enters in this network, migration of a radio station, etc. -- **** -- even when a high order connection place radio station changes, the star mold multi-hop wireless network of the number min of hop can be reconstructed similarly.

[0069] (Operation gestalt of invention given in claims 8 and 17) This operation gestalt reconstructs a multi-hop wireless network by selecting a new high order connection place radio station in a high order connection place radio station and the radio station it became impossible to connect by migration of a self-radio station, migration of a high order connection place radio station, or failure, after building a multi-hop wireless network. In addition, with this operation gestalt, each radio station shall recognize the child radio station. There are an approach of telling a high order connection place radio station about that as the concrete recognition approach when each radio station sets up a high order connection place radio station, a method of checking a child radio station, when receiving the signal from a child radio station, etc.
[0070] Drawing 14 shows the 5th operation gestalt of the procedure of the number information acquisition means 11 of hop of the radio station of this invention, and the high order connection place radio station selection means 12. In drawing, after each radio station selects a high order connection place radio station, when it becomes impossible to connect with a high order connection place radio station by migration of a self-radio station, migration of a high order connection place radio station, or failure, (k1) and this radio station newly select a high order connection place radio station (k2). In addition, the method of recognizing that it becomes impossible for a radio station to connect with a high order connection place radio station should just recognize that the information message from a high order connection place radio station cannot receive, or that the reply signal does not come on the contrary when signal transmission is transmitted to a high order connection place radio station. Moreover, in case a radio station selects a high order connection place radio station, the approach shown in each above-mentioned operation gestalt can be taken. However, this is canceled when the number information of hop from a child radio station is received (k2).
[0071] By the above processing, a high order connection place radio station and the radio station it became impossible to connect can select a high order connection place radio station except for a child radio station by migration, failure, etc. of a high order connection place radio station, and a multi-hop wireless network can be reconstructed. Thereby, the loop formation between the self-radio station by selecting a child radio station as a high order connection place radio station to produce and a child radio station is avoidable. Moreover, although it is also considered that each radio station selects a child radio station (henceforth a "grandchild radio station") as a new high order connection place radio station further, with the configuration of this invention which selects the radio station of the number of the minimum hop with a high order connection place radio station in a connectable radio station, a self-radio station and a grandchild radio station cannot be connected, and the worries do not exist. That is, with this operation gestalt, even if it becomes impossible for each radio station to connect with a high order connection place radio station, a new high order connection place radio station can be selected preventing a loop formation, and a multi-hop wireless network can be autonomously reconstructed between normal radio stations.
[0072] (Operation gestalt of invention given in claims 9 and 18) This operation gestalt reconstructs a multi-hop wireless network by selecting a new high order connection place radio station in a high order connection place radio station and the radio station it became impossible to connect by migration of a self-radio station, migration of a high order connection place radio station, or failure, after building a multi-hop wireless network. In addition, with this operation gestalt, each radio station shall recognize the child radio station.
[0073] Drawing 15 shows the 6th operation gestalt of the procedure of the number information acquisition means 11 of hop of the radio station of this invention, and the high order connection place radio station selection means 12. Drawing 15 (a) It is the procedure of a high order connection place radio station and the radio station whose connection became improper, and is drawing 15 (b). It is the procedure of a child radio station.
[0074] In drawing, after each radio station selects a high order connection place radio station, when it becomes impossible to connect with a high order connection place radio station by migration of a self-radio station, migration of a high order connection place radio station, or failure, (m1) and this radio station transmit the connection improper signal of the purport it became impossible for a self-radio station to connect with a high order connection place radio station to a child radio station (m2). And a high order connection place radio station is newly selected (m3).
[0075] On the other hand, if a child radio station receives a connection improper signal from a high order connection place radio station (n1), the connection improper signal of the purport it became impossible for a self-radio station to connect with a high order connection place radio station to the child radio station similarly will be transmitted (n2). And a high order connection place radio station is newly selected (n3). Like the following, the radio station which received the connection improper signal from the high order connection place radio station selects a new high order connection place radio station while transmitting a connection improper signal to the child radio station. In addition, in case a radio station selects a high order connection place radio station, the approach shown in each above-mentioned operation gestalt can be taken.
[0076] By the above processing, when it becomes impossible for a radio station to connect with a high order connection place radio station by migration, failure, etc. of a high order connection place radio station,

processing from which the high order connection place radio station where the child radio station and all the radio stations that the subordinate of a self-radio station has like the child radio station are new is selected is further performed with a self-radio station. Thereby, a multi-hop wireless network is reconstructible.
[0077] Drawing 16 shows the concrete example of the 6th operation gestalt of operation. drawing -- setting -- the original multi-hop wireless network -- radio station Ma-1 -- Ma, Ma+1, and Ma+2 Suppose that it connected in order. Here, it is radio station Ma-1. It carries out to it having become impossible to connect a radio station Ma. A radio station Ma is radio station Ma-1. Radio station Ma+1 which a radio station Ma and its subordinate have when it becomes impossible to connect, and Ma+2 A high order connection place radio station is newly selected. Consequently, a radio station Ma and Ma+2 A new high order connection place radio station cannot be selected, but it is radio station Ma+1. Suppose that the new high order connection place radio station Mb has been selected. At this time, it is radio station Ma+1. The number of hop is set to b+1, and is Mb+1. It is written. a radio station Ma and Ma+2 as a respectively new high order connection place radio station -- radio station Mb+1 selecting -- radio station Mb+2 ****** -- a multi-hop wireless network is reconstructed. [and]
[0078] Thus, dynamic reconstruction of a multi-hop wireless network is attained by only a high order connection place radio station and the radio station it became impossible to connect not only newly selecting a high order connection place radio station, but redoing selection of a high order connection place radio station in all the radio stations that the subordinate has.
[0079]
[Effect of the Invention] As explained above, the multi-hop wireless network and radio station of this invention acquire the number information of hop on a connectable radio station (claims 3-6, 12-15), and select one radio station where the number of hop serves as min out of a connectable radio station with a high order connection place radio station (claims 1 and 10). Moreover, when a high order connection place radio station is selected, what added 1 to the number of hop is made into the number of hop of a self-radio station, and the number information of hop is notified to each connectable radio station (claims 2 and 11). Thereby, since each radio station can select a high order connection place radio station autonomously, the multi-hop wireless network of the number min of hop can be built autonomously.
[0080] moreover -- that there is a radio station which newly enters after construction of a (claims 7 and 16) multi-hop wireless network when each radio station always selects the radio station of the number of the minimum hop as a high order connection place radio station in a connectable radio station **** -- migration of a radio station etc. -- **** -- even when a high order connection place radio station changes, a multi-hop wireless network can be reconstructed promptly. Moreover, when a radio station secedes from a network by migration, failure, etc., while the radio station which made this radio station the high order connection place radio station avoids loop structure, the multi-hop wireless network which (claims 8 and 17) and loop structure do not generate can be reconstructed by selecting autonomously a new high order connection place radio station. moreover, the thing for which all not only the radio station that made the radio station from which it seceded the high order connection place radio station but its subordinate's radio stations newly select a high order connection place radio station autonomously -- (claims 9 and 18) -- reconstruction of a multi-hop wireless network is attained dynamically. Therefore, the robustness of reconstruction of the multi-hop wireless network to balking of a radio station can be raised.
[0081] By the above, the star mold multi-hop wireless network which always makes the top office autonomously the base station of the number of the minimum hop can be built irrespective of entry or balking of a radio station in the multi-hop wireless network and radio station of this invention.

[Translation done.]

TECHNICAL FIELD

[Field of the Invention] This invention relates to the multi-hop wireless network which can relay each radio station also from the radio station which exists outside the communications area of a base station when each radio station has a junction function, and can access a base station in the star mold wireless network where two or more radio stations like mobile communications or wireless LAN access the same base station.
[0002] It is related with the multi-hop wireless network and radio station which build autonomously the junction way from each radio station to a base station especially.

[Translation done.]

PRIOR ART

[Description of the Prior Art] In mobile communications, such as PDC and PHS, each radio station once accesses the base station by which direct continuation is carried out to the communication network, in order to access a communication network. These systems take the configuration of the star mold wireless network where two or more radio stations access the same base station, and the communications area of each base station turns into area of the system concerned which can be communication service offered as it is.

[0004] Here, in the case of PDC, since the communications area of a base station attains to the radius of several km, communication service can be offered broadly in few base stations, but in the case of PHS, since the communications area of a base station remains in hundreds of m, in order to offer wide range communication service, it is necessary to arrange many base stations. Moreover, the demand of improvement in the speed of transmission speed follows on rising, use of the base station where mobile communications also use high-frequency bands, such as wireless LAN, can be considered, and transceiver area may become narrow further rather than the base station of PHS from now on.

[0005] Thus, in a system with the small communications area of a base station, there is the approach of constituting a multi-hop wireless network between radio stations as the one technique of extending service provision area. A multi-hop wireless network is the network gestalt with which between the radio station can communicate, when each radio station has a junction function and two or more radio stations which exist between them between the radio stations whose direct communication is mutually impossible relay a signal.

[0006] When this multi-hop wireless network is applied to the above-mentioned star mold wireless network, For example, if the radio station (henceforth a "junction radio station") of near with a junction function receives the signal transmitted from the radio station (henceforth "the radio station outside area") which is outside the communications area of a certain base station This junction radio station transmits the received signal to the junction radio station more near a base station (henceforth a "high order"), and this junction radio station transmits the received signal to the junction radio station of a high order further, and transmits it to a base station through the junction radio station of a high order one by one below. Thereby, a base station can receive the signal transmitted from the radio station outside area. Moreover, the signal transmitted from a base station can also follow a path completely contrary to the above, and can receive the radio station outside area.

[0007] Therefore, the radio station which is outside the communications area of a base station becomes possible [communicating with a base station] by constituting a multi-hop wireless network between each radio station. Thereby, even if the communications area of a base station like wireless LAN is a narrow system, it becomes possible to extend the service provision area of a base station autonomously between radio stations.

[0008] In the general multi-hop wireless network, in order to send the signal from the radio station of arbitration to the radio station of a transmission place, the junction way needs to be established between the transmitting agency radio station and the transmission place radio station. However, in the above-mentioned star mold wireless network, since the transmission place of the signal transmitted from each radio station is surely a base station, each radio station has just established the junction way to a base station. That is, since the number of the junction ways which each radio station establishes is one, it is enough if one high order connection place radio station (a junction radio station, base station) where each radio station carries out the junction transfer of the signal is appointed. If in other words each radio station sets a high order connection place radio station to a meaning, the signal from the radio station of arbitration will be transmitted to a base station, when each radio station transmits to a high order connection place radio station.

[0009] Therefore, what is necessary is just to build the structure (henceforth a "star mold multi-hop wireless network") where a base station is made into the top station between base station-radio stations, and each radio station sets a high order connection place radio station to a meaning, in order to apply a multi-hop wireless network to the above-mentioned star mold wireless network. Here, the example of a configuration of the star mold multi-hop wireless network which makes a base station the top office is shown in drawing 1 R> 1. In drawing, S is a base station, M is a radio station, and an arrow head shows a high order connection place radio station.

[0010] There is what [centralized-control-/ a thing] that is depended on the top station as a method of

building the conventional star mold multi-hop wireless network. This is the building method for each radio station notifying all other radio stations connectable from a local station to the top station, grasping all the star mold multi-hop wireless network configuration that can realize the top station, choosing the optimal star mold multi-hop wireless network configuration out of it, and directing a connection place to each radio station.

[Translation done.]

EFFECT OF THE INVENTION

[Effect of the Invention] As explained above, the multi-hop wireless network and radio station of this invention acquire the number information of hop on a connectable radio station (claims 3-6, 12-15), and select one radio station where the number of hop serves as min out of a connectable radio station with a high order connection place radio station (claims 1 and 10). Moreover, when a high order connection place radio station is selected, what added 1 to the number of hop is made into the number of hop of a self-radio station, and the number information of hop is notified to each connectable radio station (claims 2 and 11). Thereby, since each radio station can select a high order connection place radio station autonomously, the multi-hop wireless network of the number min of hop can be built autonomously.
[0080] moreover -- that there is a radio station which newly enters after construction of a (claims 7 and 16) multi-hop wireless network when each radio station always selects the radio station of the number of the minimum hop as a high order connection place radio station in a connectable radio station **** -- migration of a radio station etc. -- **** -- even when a high order connection place radio station changes, a multi-hop wireless network can be reconstructed promptly. Moreover, when a radio station secedes from a network by migration, failure, etc., while the radio station which made this radio station the high order connection place radio station avoids loop structure, the multi-hop wireless network which (claims 8 and 17) and loop structure do not generate can be reconstructed by selecting autonomously a new high order connection place radio station. moreover, the thing for which all not only the radio station that made the radio station from which it seceded the high order connection place radio station but its subordinate's radio stations newly select a high order connection place radio station autonomously -- (claims 9 and 18) -- reconstruction of a multi-hop wireless network is attained dynamically. Therefore, the robustness of reconstruction of the multi-hop wireless network to balking of a radio station can be raised.
[0081] By the above, the star mold multi-hop wireless network which always makes the top office autonomously the base station of the number of the minimum hop can be built irrespective of entry or balking of a radio station in the multi-hop wireless network and radio station of this invention.

[Translation done.]

TECHNICAL PROBLEM

[Problem(s) to be Solved by the Invention] Reconstruction is needed when it becomes impossible, as for such a centralized control building method, for a certain radio station to bear a junction function according to causes, such as failure and migration. In order that the top office may grasp the purport to which it became impossible for the radio station where it broke down and moved to bear a junction function in this, that radio station and the connected radio station notify that to the top office one after another first, and the top office must appoint the optimal connection place radio station of each radio station anew followed on reconstruction of a star mold multi-hop wireless network in response to this notice, and must report it to all radio stations. Moreover, the same actuation is needed also when a radio station is newly added.

[0012] Therefore, by the centralized control building method, when it became impossible for a certain radio station to act as intermediary according to causes, such as failure and migration, or when a radio station was newly added, the time amount which reconstruction of a star mold multi-hop wireless network takes became long, and there was a problem as for which modification of network configuration is not made immediately. Moreover, there was a problem on which traffic for control, such as change-notice traffic for modification and information traffic, increases.

[0013] All the top offices (base station) do not control construction of a star mold multi-hop wireless network, but this invention aims to let each radio station offer the multi-hop wireless network and radio station which can be built autonomously by finding the radio station of a connection place with each optimal radio station.

[Translation done.]

MEANS

[Means for Solving the Problem] Invention of a publication shows the method of building a multi-hop wireless network to claims 1 and 2. Namely, the number information acquisition means of hop of each radio station acquires the number information of hop from a connectable radio station. When the direct continuation of the high order connection place radio station selection means can be carried out to a base station, a base station is selected as a high order connection place radio station. When direct continuation cannot be carried out to a base station, one connectable radio station where the number of hop obtained using the number information of hop serves as min is selected as a high order connection place radio station from connectable radio stations. When a signal transfer means can carry out direct continuation of the signal received from the sending signal or the child radio station to a high order connection place radio station or a base station, each radio station can build a multi-hop wireless network autonomously by transmitting to a base station.
[0015] In addition, although this is premised on each radio station recognizing the number of hop of a self-radio station beforehand, when it is undecided, it decides sequentially from the direction near a base station. Namely, the number information acquisition means of the other radio station of hop is decided [by the number information acquisition means of hop of a base station and the radio station which can carry out direct continuation setting up the number of a self-radio station of hop with 1] sequentially from the direction with the number of each radio station which constitutes a multi-hop wireless network near a base station of hop by setting up what added 1 to the number of hop of the high order connection place radio station which the high order connection place radio station selection means selected as the number of hop of a self-radio station. And each radio station can build a multi-hop wireless network autonomously by selecting one high order connection place radio station in each radio station, respectively.
[0016] Invention according to claim 3 to 5 shows the configuration of the number information acquisition means of hop of a radio station. That is, the number information acquisition means of hop of the radio station of claim 3 is a configuration which receives this information message and acquires the number information of hop on a connectable radio station while always transmitting the information message which contains the number of hop of a self-radio station as number information of hop in multiple address.
[0017] The number information acquisition means of hop of the radio station of claim 4 is a configuration which acquires the number information of hop on a connectable radio station by the receiving timing of this information message while transmitting an information message in multiple address as number information of hop by the transmit timing based on the number of hop of a self-radio station.
[0018] It is the configuration which the radio station which the number information acquisition means of the radio station of claim 5 of hop transmitted the signal which requires as notifying that number information of hop to a connectable radio station, transmitted it to the connectable radio station which required the signal with which the connectable radio station which received this demand signal answers the number information of hop on a self-radio station, and received this reply signal acquires in the number information of hop on a connectable radio station.
[0019] the above -- by any configuration, the number information acquisition means of hop can acquire the number information of hop from a connectable radio station, and if one connectable radio station where the number of hop serves as min from the inside is selected as a high order connection place radio station, a multi-hop wireless network will be built autonomously.
[0020] Invention according to claim 6 shows a configuration in case a new radio station enters into a multi-hop wireless network. [whether the number information acquisition means of hop of the radio station receives the information message from a connectable radio station, and acquires the number information of hop, and] By acquiring the number information of hop by the receiving timing of the information message from a connectable radio station, or transmitting a demand signal to a connectable radio station, receiving the reply signal according to it, and acquiring the number information of hop One connectable radio station where the number of hop serves as min can be selected as a high order connection place radio station, and it can join a multi-hop wireless network.
[0021] Invention according to claim 7 to 9 shows the configuration in the case of reconstructing a multi-hop

wireless network. That is, after the number information acquisition means of hop of the radio station of claim 7 and a high order connection place radio station selection means build a multi-hop wireless network, they are the configuration which selects one connectable radio station where the number of hop serves as min out of a connectable radio station to predetermined timing, and selects the connectable radio station as a new high order connection place radio station when the connectable radio station and the present high order connection place radio station are inequalities.

[0022] When connection becomes impossible with a high order connection place radio station after the number information acquisition means of hop of the radio station of claim 8 and a high order connection place radio station selection means build a multi-hop wireless network, they are the configuration which selects one connectable radio station where the number of hop serves as min except for a child radio station out of a connectable radio station anew as a high order connection place radio station.

[0023] The number information acquisition means of hop of the radio station of claim 9, and a high order connection place radio station selection means When connection becomes impossible with a high order connection place radio station after building a multi-hop wireless network A connection improper signal reports that to a child radio station, and one connectable radio station where the number of hop serves as min out of a connectable radio station anew after information is selected as a high order connection place radio station. Moreover, the radio station which received the connection improper signal from the high order connection place radio station is a configuration which selects a new high order connection place radio station while reporting a connection improper signal to a child radio station similarly.

[0024] Invention according to claim 10 to 18 shows the configuration of the radio station corresponding to a multi-hop wireless network according to claim 1 to 9.

[0025]

[Embodiment of the Invention] (Operation gestalt of invention given in claims 1, 2, 10, and 11) Drawing 2 shows the operation gestalt of the radio station which constitutes the multi-hop wireless network of this invention. A radio station is equipped with a number information acquisition means 11 of hop acquire the number information of hop from a connectable radio station, a high order connection place radio station selection means 12 select the high order connection place radio station which serves as a junction place out of a connectable radio station according to this number information of hop, and a signal transfer means 13 transmit the signal which received from the sending signal or the child radio station to a high order connection place radio station or a base station, in drawing.

[0026] Drawing 3 shows the fundamental procedure of the high order connection place radio station selection means 12. First, when the direct continuation of the radio station can be carried out to a base station, a base station is selected as a high order connection place radio station (a1). Next, when direct continuation cannot be carried out to a base station, the number information of hop on the connectable radio station which the number information acquisition means 11 of hop acquired is inputted (a2), and one connectable radio station where the number information of hop on each connectable radio station is compared, and the number of hop serves as min from the inside is selected as a high order connection place radio station (a3). The high order connection place radio station selected here is notified to the signal transfer means 13, and serves as the destination of the signal received from the child radio station.

[0027] Moreover, if a high order connection place radio station is selected (a3), what added 1 to the number of hop will be recognized as the number of hop of a self-radio station, and the number information of hop will be notified to the number information acquisition means 11 of hop of a connectable radio station (a4). The number information acquisition means 11 of hop notifies the number information of hop to a connectable radio station by the approach explained below. In addition, the number information acquisition means 11 of hop of a base station and the radio station which can carry out direct continuation recognizes the number of hop of a self-radio station to be 1, and the other number information acquisition means 11 of hop of a radio station recognizes what added 1 to the number of hop of the high order connection place radio station which the high order connection place radio station selection means 12 selected as the number of hop of a self-radio station. Moreover, a base station may be treated as one radio station, and the number of hop of a base station may be defined as 0.

[0028] Drawing 4 shows an example of the process in which a multi-hop wireless network is constituted by the radio station of this invention. In drawing, one hop is set to the number information acquisition means 11 of hop of the radio station M1 which can carry out direct continuation to a base station S. Next, if this radio station M1 is decided, when the radio station which makes this a connectable radio station selects one radio station M1 as a high order connection place radio station, respectively, it will be decided to each radio station M1 that the radio station M2 used as two hop will be the shape of a tree. Radio stations M3, M4, --, Mk are decided one by one like the following. Here, Mk shows the radio station whose number of hop is k.

[0029] Now, a radio station Mx presupposes that it has newly entered in a network. A radio station Mx chooses one radio station M2 where the number of hop serves as min out of the radio stations M2, M3, and M4 which are connectable radio stations, and selects this as a high order connection place radio station. By this, the number

of hop of a radio station Mx is set to 3, and will be connected to one radio station M2 as a high order connection place radio station. Thus, each radio station appoints only one high order connection place radio station, respectively. Thereby, each radio station is connected to a high order connection place radio station, and the multi-hop wireless network which makes a base station the top station is formed between a base station and each radio station.

[0030] Drawing 5 shows the fundamental procedure of the signal transfer means 13. Drawing 5 (a) It is the procedure of the signal transfer means 13 in a transmitting agency radio station. The signal transfer means 13 in a transmitting agency radio station will transmit the sending signal to a high order connection place radio station, if the sending signal addressed to a base station occurs (b1) (b2). Drawing 5 (b) It is the procedure of the signal transfer means 13 in a junction radio station. The signal transfer means 13 in a junction radio station will transmit the received signal to a high order connection place radio station, if a signal is received from a child radio station (c1) (c2).

[0031] The signal transmitted by actuation of such a signal transfer means 13 of a radio station from the radio station which exists outside the communications area of a base station can also be transmitted to a base station. The situation of this signal transfer is shown in drawing 6 .

[0032] Radio station Mk-1 which is a high order connection place radio station first when the radio station Mk which exists outside the communications area of a base station S transmits a signal to a base station in drawing 6 A signal is transmitted. Radio station Mk-1 which received this signal Radio station Mk-2 which is a high order connection place radio station similarly An input signal is transmitted. Hereafter, each radio station transmits an input signal to a high order connection place radio station, respectively, and, finally a radio station M1 transmits an input signal to a base station S. When transmitting a signal to a radio station Mk from a base station S, it can transmit by following this path conversely.

[0033] With the above procedure, each radio station can select a high order connection place radio station, and the multi-hop wireless network which makes a base station the top office can be built autonomously. Moreover, since each radio station has selected the radio station of the number of the minimum hop from connectable radio stations to the high order connection place radio station, the multi-hop wireless network where the number of hop serves as min is built automatically. Moreover, the junction way to which the signal transmitted from the radio station which exists outside the communications area of a base station is transmitted to a base station through 1 or two or more junction radio stations is automatically establishable by transmitting the signal which each radio station received from the child radio station to a high order connection place radio station.

[0034] (Operation gestalt of invention given in claims 3 and 12) This operation gestalt transmits the information message (henceforth "the number message of hop") in which the number information acquisition means 11 of hop of each radio station included the number of hop of a self-radio station in multiple address, and receives this number message of hop, and acquires the number of hop of a connectable radio station. In addition, when a base station transmits the number message of hop in multiple address similarly, the number of hop of a base station is defined as 0. The carrier for the number messages of hop shall be beforehand defined in this network.

[0035] Drawing 7 shows the 1st operation gestalt of the procedure of the number information acquisition means 11 of hop of a radio station, and the high order connection place radio station selection means 12. In drawing, in case the number information acquisition means 11 of hop of each radio station tends to acquire the number of hop of a connectable radio station, search-time t of the number message of hop is set up first (d1), and the flag 0 which shows an initial state is set up (d2).

[0036] Next, supervising whether it went through search-time t, the carrier for the number messages of hop is searched (d4), and receiving level judges whether the signal beyond a threshold L was received (d5). (d3) Receiving level restores to this signal, when the signal beyond a threshold L is received, and it judges whether it is the number message of hop (d6). In addition, it is the decision criterion which judges whether this threshold L is connectable with the radio station where a self-radio station transmits this signal, and is the minimum receiving level which specifically chooses a connectable radio station. On the other hand, when receiving level is under the threshold L, it returns to the search (d3, d4) of the carrier for the number messages of hop.

[0037] When an input signal is the number message of hop, the number of hop and the transmitting agency radio station ID are read, and the number of hop of a connectable radio station is acquired (d7). On the other hand, when an input signal is not the number message of hop, it returns to the search (d3, d4) of the carrier for the number messages of hop again. Next, it judges whether it is a flag 0 about whether the number of hop of the acquired connectable radio station is the beginning (d8). Since it is a flag 0 at first, the number of hop of the acquired connectable radio station is memorized (d9), and it is set as a flag 1 (d10), and returns to the search (d3, d4) of the carrier for the number messages of hop again.

[0038] When the following number message of hop is received, it is No with a flag 1d8. It becomes and compares with the number of hop of the already memorized connectable radio station (d11). In being smaller than the number of hop which the number of hop of the newly acquired connectable radio station has memorized, the number of hop of the memorized connectable radio station is eliminated, and it memorizes the number of hop of

the newly acquired connectable radio station (d12). It is larger than the number of hop which the number of hop of the connectable radio station newly acquired on the other hand has memorized, or in being equal, the number of hop of the memorized connectable radio station is left as it is, and it returns to the search (d3, d4) of the carrier for the number messages of hop again. In addition, when equal to the number of hop which the number of hop of the newly acquired connectable radio station has memorized, you may change to the number of hop of the newly acquired connectable radio station, receiving level is compared, the larger one is chosen, and you may make it memorize. By this, the minimum thing will always be memorized in the acquired number of hop of a connectable radio station.

[0039] Moreover, although it is always supervising whether search-time t was exceeded from search initiation during the search (d3), when having not gone through search-time t, the search of the carrier for the number messages of hop is continued (d4). On the other hand, when it goes through search-time t, the search of the carrier for the number messages of hop is considered as termination, and it is judged that the number of hop of the connectable radio station memorized at present is min (d13).

[0040] By the above processing, each radio station can recognize the radio station of the number of the minimum hop with the number of hop acquired from the number message of hop of a connectable radio station. And this radio station is selected with a high order connection place radio station (a3 of drawing 3). In the radio station which has selected one high order connection place radio station from connectable radio stations, what added 1 to the number of hop of a high order connection place radio station is made into the number of hop of a self-radio station, and the number message of hop incorporating the number of hop is transmitted in multiple address (a4 of drawing 3).

[0041] (Operation gestalt of invention given in claims 4 and 13) The number information acquisition means 11 of hop of each radio station transmits an information message (henceforth "the number timing message of hop") in multiple address by the transmit timing based on the number of hop of a self-radio station, and this operation gestalt recognizes the number of hop of a connectable radio station by the receiving timing of this number timing message of hop. In addition, when a base station transmits the number timing message of hop in multiple address by predetermined transmit timing similarly, the number of hop of a base station is defined as 0, and the transmit timing according to it is set up. The carrier for the number timing messages of hop shall be beforehand defined in this network.

[0042] Drawing 8 shows an example of the timing to which a base station and each radio station transmit the number timing message of hop. In drawing, the information time zone L, the base station, and each radio station where a base station and each radio station transmit the number timing message of hop are divided into the information time interval D which does not transmit any number timing message of hop, and a time-axis repeats this the information period T. However, it is necessary to take the larger information time interval D than the information time zone L.

[0043] The information time zone L is classified into the class information time zone when the radio station where the number of hop is the same transmits the number timing message of hop. For example, only a base station can transmit the number timing message P0 of hop at the first class information time zone, and only a radio station with one hop can transmit the number timing message P1 of hop, and makes the next class information time zone like the following 2 and 3 hop and the thing of -- to which only a radio station can transmit the number timing messages P2 and P3 of hop, and -- for every class information time zone, respectively. A base station and each radio station transmit the number timing message of hop to every information period T in the class information time zone corresponding to each number of hop.

[0044] Drawing 9 shows the 2nd operation gestalt of the procedure of the number information acquisition means 11 of hop of a radio station, and the high order connection place radio station selection means 12. In drawing, in case the number information acquisition means 11 of hop of each radio station tends to acquire the number of hop of a connectable radio station, the flag 0 which shows an initial state is set up (f1), and the count N of the confirmation of receipt of the number timing message of hop is set up (f2).

[0045] Next, the carrier for the number timing messages of hop is searched (f3), and receiving level judges whether the signal beyond a threshold L was received (f4). Receiving level restores to this signal, when the signal beyond a threshold L is received, and it judges whether it is the number timing message of hop (f5). In addition, it is the decision criterion which judges whether this threshold L is connectable with the radio station where a self-radio station transmits this signal, and is the minimum receiving level which specifically chooses a connectable radio station. On the other hand, when receiving level is under the threshold L, or when an input signal is not the number timing message of hop, it returns to the search (f3) of the carrier for the number timing messages of hop.

[0046] When an input signal is the number timing message of hop, it judges whether it is a flag 0 (f6). It is the time of day T0 which received the number timing message of hop first since it was a flag 0 at first. It carries out, the present time of day is set up (f7), and the transmitting agency radio station ID is acquired and memorized from the number timing message of hop which received (f8). Next, it is set as n= 1 which shows that it was set

as the flag 1 (f9), and the number timing message of hop which received further was first received in the information time zone L, and the number timing message of hop was received for the first time (f10), and returns to the search (f3) of the carrier for the number timing messages of hop again.
[0047] the case where the following number timing message of hop is received -- a flag one f6 -- No The receipt time T0 of the number timing message of hop which became and received previously from -- elapsed time judges whether it is more than the information time zone L (f11). If this elapsed time is not more than L (it is No at f11), the number timing message of hop which received will judge that it is not what received first in the information time zone L, will disregard that reception, and will return to the search (f3) of the carrier for the number timing messages of hop again. on the other hand -- the previous receipt time T0 from -- with [elapsed time] L [more than] (it is Yes at f11), the number timing message of hop which received judges that it is the first reception in the information time zone L, and performs the following processings.
[0048] First, time of day T0 The transmitting agency radio station ID is acquired from the number timing message of hop which reset at current time (f12) and received (f13), and it judges whether the transmitting agency radio station ID remembered to be the this transmitting former radio station ID is in agreement (f14). When both are in agreement, the number timing message of hop which received judges whether since it means that it is received first and the further last number timing message of hop was again received also this information period in the information time zone L, 1 was added to n (f15) and n became the count N of a check (f16). If n has not become the count N of a check, it returns to the search (f3) of the carrier for the number timing messages of hop again. On the other hand, if n has become the count N of a check, it will be decided that the number timing message of hop which received is first received in the information time zone L, and it will recognize that the memorized transmitting agency radio station ID is a radio station of the number of the minimum hop in a connectable radio station (f17).
[0049] Moreover, when the transmitting agency radio station ID remembered to be the transmitting agency radio station ID is an inequality, it can be recognized as what was received to different timing from the number timing message of hop by which No) and the number timing message of hop which received were first received in the last information time zone L (f14 unlike the last thing. Therefore, the memorized transmitting agency radio station ID is eliminated, and the transmitting agency radio station ID read in the number timing message of hop which received now is newly memorized (f18). Then, it initializes to n= 1 (f19), and returns to the search (f3) of the carrier for the number timing messages of hop again.
[0050] Drawing 10 shows the concrete example of the 2nd operation gestalt of operation. It sets to drawing and is the first information period Ta. Although the number timing messages P3 and P4 of hop are continuously received to the timing then corresponding to 3 and 4 hop, P3 receives first in the information time zone L, and memorizes the connectable radio station as a radio station of the number of the minimum hop (f8). P4 [and] received continuously -- the receipt time T0 of P3 from -- since it is less than the information time zone L, it is ignored (it is No at f11).
[0051] next, the receipt time T0 of P3 from -- the number timing message of hop received above the information time zone L is supervised. Namely, the following information period Tb Since it supervises whether the number timing message of hop is received and the number timing message P2 of hop corresponding to two hop is received here, the connectable radio station is memorized as a radio station of the number of the minimum hop (being f11 Yes, f18). Information period Tb P3 and P4 which can be set are disregarded (being f11 No).
[0052] next, the receipt time T0 of P2 from -- the number timing message of hop received above the information time zone L is supervised. Namely, the following information period Tc It supervises whether the number timing message of hop is received, and P2 is received again here (it is Yes and f14 in f11, and is Yes). When N time reception of these P2 is carried out similarly, the connectable radio station which transmitted P2 is decided as a radio station of the number of the minimum hop (f17).
[0053] By the above processing, each radio station can supervise the receiving timing of the number timing message of hop, and the radio station first transmitted in the information time zone L out of the connectable radio station, i.e., the number of hop, can recognize the minimum radio station. Moreover, the radio station which transmitted the number timing message of hop first can be checked over multiple times by preparing the count of a check in an information time zone. And this radio station is selected with a high order connection place radio station (a3 of drawing 3).
[0054] In the radio station which has selected one high order connection place radio station from connectable radio stations, what added 1 to the number of hop of a high order connection place radio station is made into the number of hop of a self-radio station, and the number timing message of hop is transmitted in multiple address by the transmit timing corresponding to the number of hop (a4 of drawing 3). This concrete procedure is explained with reference to drawing 11 .
[0055] In drawing 11 , each radio station's selection of a high order connection place radio station judges in the class information time zone of what position the high order connection place radio station has transmitted the

number timing message of hop based on the conventional time O (g2). (g1) If each radio station recognizes beforehand the time amount length of a class information time zone, this decision is possible when the time amount which received the number timing message of hop from a high order connection place radio station calculates what time of that time amount length it is by measuring from the conventional time O. If the class information time zone when the high order connection place radio station has transmitted the number timing message of hop is known, the number timing message of hop of a self-radio station will be transmitted in the next class information time zone (g3).

[0056] In addition, when there are two or more radio stations which transmit the number timing message of hop in the same class information time zone, the number timing message of hop of a self-radio station is transmitted to the timing which is not transmitted from other radio stations by carrier sense etc. Thereby, each radio station can transmit the number timing message of hop by the transmit timing (class information time zone) corresponding to the number of hop, and can notify the information which is equivalent to the number of hop to a connectable radio station.

[0057] Each radio station only adjusts the transmit timing of an information message, out of a connectable radio station, each radio station recognizes the radio station of the number of the minimum hop, and this operation gestalt can carry out the thing of it. Therefore, even when the number of hop cannot be incorporated into an information message, if each radio station is the communication system which can recognize the conventional time O of an information message, it can apply. For example, it is applicable to the communication system which has taken the synchronization of each radio station by the existing information message beforehand like PHS.

[0058] (Operation gestalt of invention given in claims 5 and 14) This operation gestalt the number information acquisition means 11 of hop of each radio station -- a connectable radio station -- the number information of hop (the number message of hop --) The signal required as notifying the number timing message of hop is transmitted. It transmits to the connectable radio station which required the signal with which the connectable radio station which received this demand signal answers the number information of hop on a self-radio station, and the radio station which received this reply signal acquires the number information of hop on a connectable radio station.

[0059] Drawing 12 shows the 3rd operation gestalt of the procedure of the number information acquisition means 11 of hop of the radio station of this invention, and the high order connection place radio station selection means 12. In drawing, in case the number information acquisition means 11 of hop of each radio station tends to acquire the number information of hop on a connectable radio station, the number information-requirements signal of hop is first transmitted in multiple address towards a circumference radio station (h1). The circumference radio station which received this number information-requirements signal of hop judges whether receiving level is received above a threshold L (i1). The radio station where receiving level received the number information-requirements signal of hop above the threshold L turns into a connectable radio station to a transmitting agency radio station (i2). In addition, it is the decision criterion which judges whether this threshold L is connectable with the radio station where a self-radio station transmits this signal, and is the minimum receiving level which specifically chooses a connectable radio station.

[0060] The number information acquisition means 11 of hop of a connectable radio station transmits the reply signal which notifies the number information of hop on a self-radio station to a transmitting agency radio station (i3). In addition, the number message of hop incorporating the number of hop is sufficient as this reply signal, and the number timing message of hop transmitted by the transmit timing corresponding to the number of hop is sufficient as it.

[0061] A number information acquisition means 11 of hop of a radio station by which the number information-requirements signal of hop was transmitted recognizes the radio station of the number of the minimum hop out of a connectable radio station by receiving this reply signal by the configuration shown in the operation gestalt of the above 1st, or the 2nd operation gestalt (h2).

[0062] By the above processing, each radio station can recognize the radio station of min [number / of hop] out of a connectable radio station. And this radio station is selected with a high order connection place radio station (a3 of drawing 3). In the radio station which has selected one high order connection place radio station from connectable radio stations, what added 1 to the number of hop of a high order connection place radio station is recognized as the number of hop of a self-radio station, and a connectable radio station answers the number information of hop in multiple address according to the number information-requirements signal of hop (a4 of drawing 3).

[0063] With this operation gestalt, only when each radio station receives the number information-requirements signal of hop, the message which tells the number of hop is transmitted. Therefore, since it is not necessary to transmit the signal which tells the number information of hop always in multiple address like the operation gestalt of the above 1st, or the 2nd operation gestalt, it becomes possible to stop traffic.

[0064] The new radio station which newly entered in the multi-hop wireless network can apply the operation gestalt of the procedure of the number information acquisition means 11 of hop of the radio station shown

above, and the high order connection place radio station selection means 12, in case it is going to acquire the number information of hop on a connectable radio station (claims 6 and 15). Thereby, the high order connection place radio station to a new radio station is decided, and entry to a multi-hop wireless network is attained. Moreover, after building a multi-hop wireless network, in case each radio station tends to acquire the number information of hop on a connectable radio station to predetermined timing, you may apply. This becomes reconstructible [a multi-hop wireless network]. Hereafter, the characteristic procedure in reconstruction of a multi-hop wireless network is explained.

[0065] (Operation gestalt of invention given in claims 7 and 16) Drawing 13 shows the 4th operation gestalt of the procedure of the number information acquisition means 11 of hop of the radio station of this invention, and the high order connection place radio station selection means 12. The number of hop out of a connectable radio station considers as the time amount the radio station where the number information acquisition means 11 of (j1) hop serves as min is again recognized to be after each radio station selects a high order connection place radio station in drawing, and it is the search stop time Ts. It sets up (j2). Next, search stop time Ts Progress recognizes again the radio station where the number of hop serves as min out of a connectable radio station (j4). (j3) And the radio station of the number of the minimum hop which it had a new appreciation of judges whether it is in agreement with a current high order connection place radio station (j5). When both are in agreement, a high order connection place radio station is not changed, but it is the search stop time Ts again. It returns to a setup (j2).

[0066] On the other hand, when the radio station of the number of the minimum hop which it had a new appreciation of, and the present high order connection place radio station are inequalities, it means that the connectable radio station with few hop than a high order connection place radio station had appeared, and changes to the radio station of the number of the minimum hop which had a new appreciation of a high order connection place radio station have (j6).

[0067] in addition, the approach of having a new appreciation of the radio station of the number of the minimum hop out of a connectable radio station -- operation gestalt [of the above 1st] - the procedure shown in the 3rd operation gestalt is adopted. Moreover, when the procedure shown in the operation gestalt of the above 1st or the 3rd operation gestalt is adopted, the number of hop of the radio station of the number of the minimum hop which it had a new appreciation of is compared with the number of hop of a current high order connection place radio station, and when the former is small, you may change to the radio station of the number of the minimum hop which had a new appreciation of a high order connection place radio station have.

[0068] By the above processing, each radio station can always select the radio station of the number of the minimum hop in a connectable radio station as a high order connection place radio station. Therefore, when a new radio station enters in this network, when the number of hop of a new radio station is smaller than the number of hop of the high order connection place radio station of a self-radio station, this radio station can change a high order connection place radio station to a new radio station autonomously temporarily. thus, the case where a new radio station enters in this network, migration of a radio station, etc. -- **** -- even when a high order connection place radio station changes, the star mold multi-hop wireless network of the number min of hop can be reconstructed similarly.

[0069] (Operation gestalt of invention given in claims 8 and 17) This operation gestalt reconstructs a multi-hop wireless network by selecting a new high order connection place radio station in a high order connection place radio station and the radio station it became impossible to connect by migration of a self-radio station, migration of a high order connection place radio station, or failure, after building a multi-hop wireless network. In addition, with this operation gestalt, each radio station shall recognize the child radio station. There are an approach of telling a high order connection place radio station about that as the concrete recognition approach when each radio station sets up a high order connection place radio station, a method of checking a child radio station, when receiving the signal from a child radio station, etc.

[0070] Drawing 14 shows the 5th operation gestalt of the procedure of the number information acquisition means 11 of hop of the radio station of this invention, and the high order connection place radio station selection means 12. In drawing, after each radio station selects a high order connection place radio station, when it becomes impossible to connect with a high order connection place radio station by migration of a self-radio station, migration of a high order connection place radio station, or failure, (k1) and this radio station newly select a high order connection place radio station (k2). In addition, the method of recognizing that it becomes impossible for a radio station to connect with a high order connection place radio station should just recognize that the information message from a high order connection place radio station cannot receive, or that the reply signal does not come on the contrary when signal transmission is transmitted to a high order connection place radio station. Moreover, in case a radio station selects a high order connection place radio station, the approach shown in each above-mentioned operation gestalt can be taken. However, this is canceled when the number information of hop from a child radio station is received (k2).

[0071] By the above processing, a high order connection place radio station and the radio station it became

impossible to connect can select a high order connection place radio station except for a child radio station by migration, failure, etc. of a high order connection place radio station, and a multi-hop wireless network can be reconstructed. Thereby, the loop formation between the self-radio station by selecting a child radio station as a high order connection place radio station to produce and a child radio station is avoidable. Moreover, although it is also considered that each radio station selects a child radio station (henceforth a "grandchild radio station") as a new high order connection place radio station further, with the configuration of this invention which selects the radio station of the number of the minimum hop with a high order connection place radio station in a connectable radio station, a self-radio station and a grandchild radio station cannot be connected, and the worries do not exist. That is, with this operation gestalt, even if it becomes impossible for each radio station to connect with a high order connection place radio station, a new high order connection place radio station can be selected preventing a loop formation, and a multi-hop wireless network can be autonomously reconstructed between normal radio stations.

[0072] (Operation gestalt of invention given in claims 9 and 18) This operation gestalt reconstructs a multi-hop wireless network by selecting a new high order connection place radio station in a high order connection place radio station and the radio station it became impossible to connect by migration of a self-radio station, migration of a high order connection place radio station, or failure, after building a multi-hop wireless network. In addition, with this operation gestalt, each radio station shall recognize the child radio station.

[0073] Drawing 15 shows the 6th operation gestalt of the procedure of the number information acquisition means 11 of hop of the radio station of this invention, and the high order connection place radio station selection means 12. Drawing 15 (a) It is the procedure of a high order connection place radio station and the radio station whose connection became improper, and is drawing 15 (b). It is the procedure of a child radio station.

[0074] In drawing, after each radio station selects a high order connection place radio station, when it becomes impossible to connect with a high order connection place radio station by migration of a self-radio station, migration of a high order connection place radio station, or failure, (m1) and this radio station transmit the connection improper signal of the purport it became impossible for a self-radio station to connect with a high order connection place radio station to a child radio station (m2). And a high order connection place radio station is newly selected (m3).

[0075] On the other hand, if a child radio station receives a connection improper signal from a high order connection place radio station (n1), the connection improper signal of the purport it became impossible for a self-radio station to connect with a high order connection place radio station to the child radio station similarly will be transmitted (n2). And a high order connection place radio station is newly selected (n3). Like the following, the radio station which received the connection improper signal from the high order connection place radio station selects a new high order connection place radio station while transmitting a connection improper signal to the child radio station. In addition, in case a radio station selects a high order connection place radio station, the approach shown in each above-mentioned operation gestalt can be taken.

[0076] By the above processing, when it becomes impossible for a radio station to connect with a high order connection place radio station by migration, failure, etc. of a high order connection place radio station, processing from which the high order connection place radio station where the child radio station and all the radio stations that the subordinate of a self-radio station has like the child radio station are new is selected is further performed with a self-radio station. Thereby, a multi-hop wireless network is reconstructible.

[0077] Drawing 16 shows the concrete example of the 6th operation gestalt of operation. drawing -- setting -- the original multi-hop wireless network -- radio station Ma-1 -- Ma, Ma+1, and Ma+2 Suppose that it connected in order. Here, it is radio station Ma-1. It carries out to it having become impossible to connect a radio station Ma. A radio station Ma is radio station Ma-1. Radio station Ma+1 which a radio station Ma and its subordinate have when it becomes impossible to connect, and Ma+2 A high order connection place radio station is newly selected. Consequently, a radio station Ma and Ma+2 A new high order connection place radio station cannot be selected, but it is radio station Ma+1. Suppose that the new high order connection place radio station Mb has been selected. At this time, it is radio station Ma+1. The number of hop is set to b+1, and is Mb+1. It is written. a radio station Ma and Ma+2 as a respectively new high order connection place radio station -- radio station Mb+1 selecting -- radio station Mb+2 ****** -- a multi-hop wireless network is reconstructed. [and]

[0078] Thus, dynamic reconstruction of a multi-hop wireless network is attained by only a high order connection place radio station and the radio station it became impossible to connect not only newly selecting a high order connection place radio station, but redoing selection of a high order connection place radio station in all the radio stations that the subordinate has.

[Translation done.]

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] Drawing showing the example of a configuration of a star mold multi-hop wireless network.
[Drawing 2] The block diagram showing the operation gestalt of the radio station which constitutes the multi-hop wireless network of this invention.
[Drawing 3] The flow chart which shows the fundamental procedure of the high order connection place radio station selection means 12.
[Drawing 4] Drawing showing an example of the process in which a multi-hop wireless network is constituted by the radio station of this invention.
[Drawing 5] The flow chart which shows the fundamental procedure of the signal transfer means 13.
[Drawing 6] Drawing showing signs that a signal is transmitted from the radio station outside the communications area of a base station to a base station.
[Drawing 7] The flow chart which shows the 1st operation gestalt of the procedure of the number information acquisition means 11 of hop, and the high order connection place radio station selection means 12.
[Drawing 8] An example of the timing which transmits the number timing message of hop of a base station and each radio station.
[Drawing 9] The flow chart which shows the 2nd operation gestalt of the procedure of the number information acquisition means 11 of hop, and the high order connection place radio station selection means 12.
[Drawing 10] Drawing showing concrete actuation of the 2nd operation gestalt.
[Drawing 11] The flow chart which shows the transmitting procedure of the number information of hop in the 2nd operation gestalt.
[Drawing 12] The flow chart which shows the 3rd operation gestalt of the procedure of the number information acquisition means 11 of hop, and the high order connection place radio station selection means 12.
[Drawing 13] The flow chart which shows the 4th operation gestalt of the procedure of the number information acquisition means 11 of hop, and the high order connection place radio station selection means 12.
[Drawing 14] The flow chart which shows the 5th operation gestalt of the procedure of the number information acquisition means 11 of hop, and the high order connection place radio station selection means 12.
[Drawing 15] The flow chart which shows the 6th operation gestalt of the procedure of the number information acquisition means 11 of hop, and the high order connection place radio station selection means 12.
[Drawing 16] Drawing showing the concrete example of the 6th operation gestalt of operation.
[Description of Notations]
S Base station
M Radio station
11 The Number Information Acquisition Means of Hop
12 High Order Connection Place Radio Station Selection Means
13 Signal Transfer Means

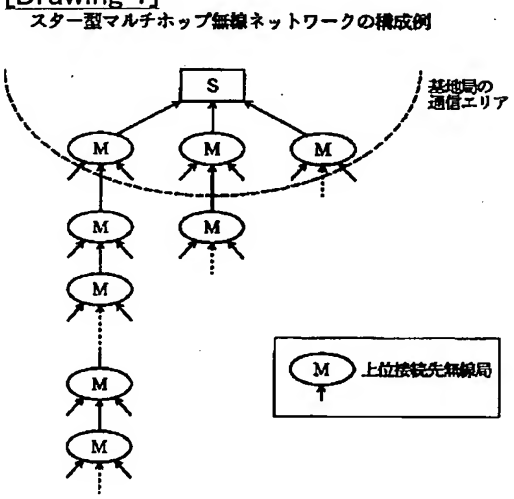
[Translation done.]

* NOTICES *

1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

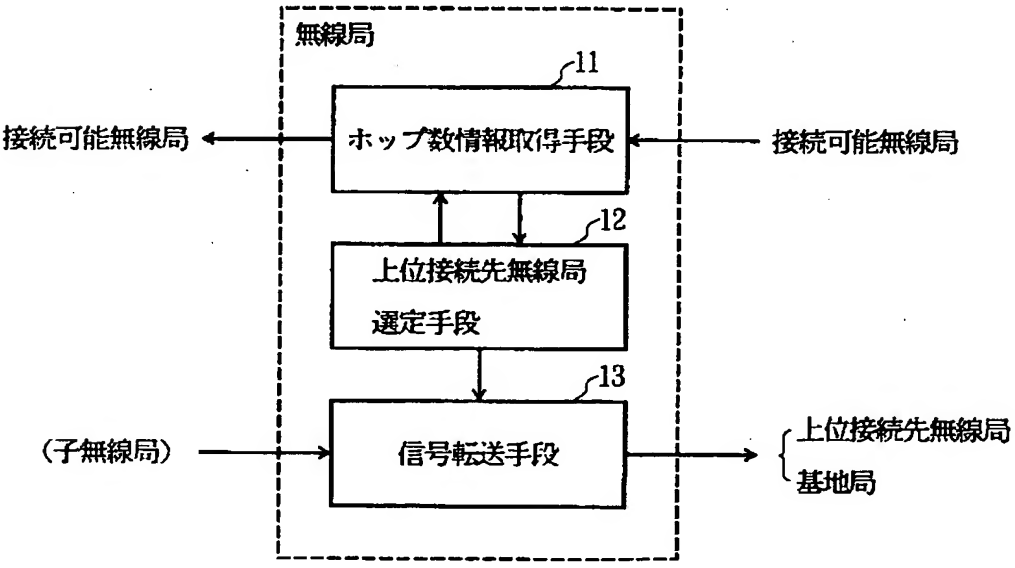
DRAWINGS

[Drawing 1]



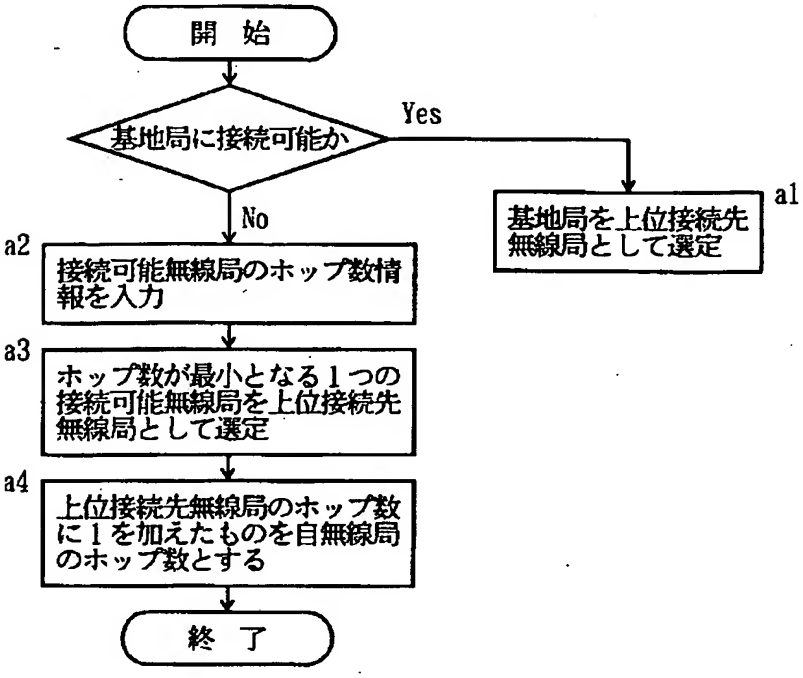
[Drawing 2]

本発明のマルチホップ無線ネットワークを構成する無線局の実施形態



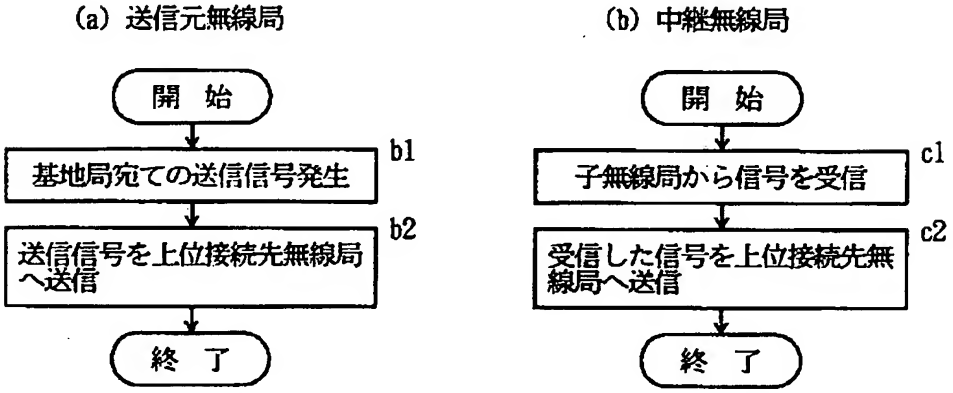
[Drawing 3]

上位接続先無線局選定手段12の基本的な処理手順



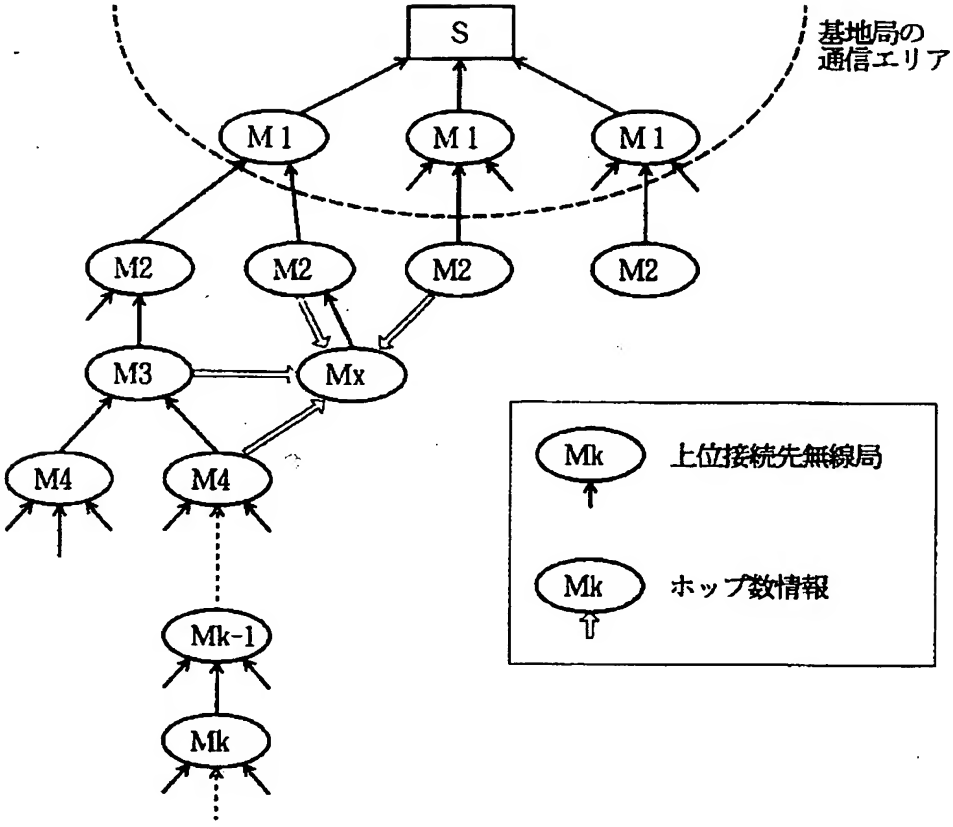
[Drawing 5]

信号転送手段13の基本的な処理手順

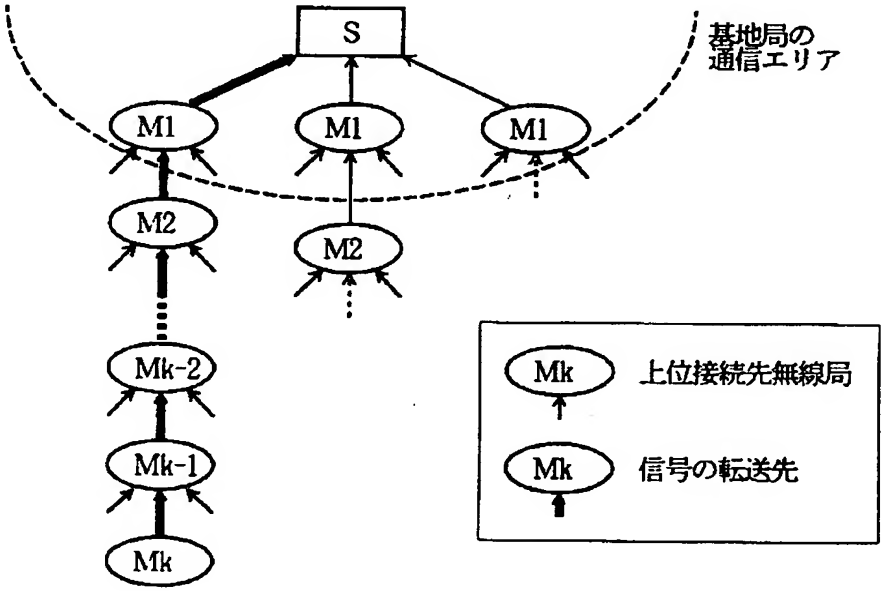


[Drawing 4]

本発明の無線局によってマルチホップ無線ネットワークが構成される過程の一例

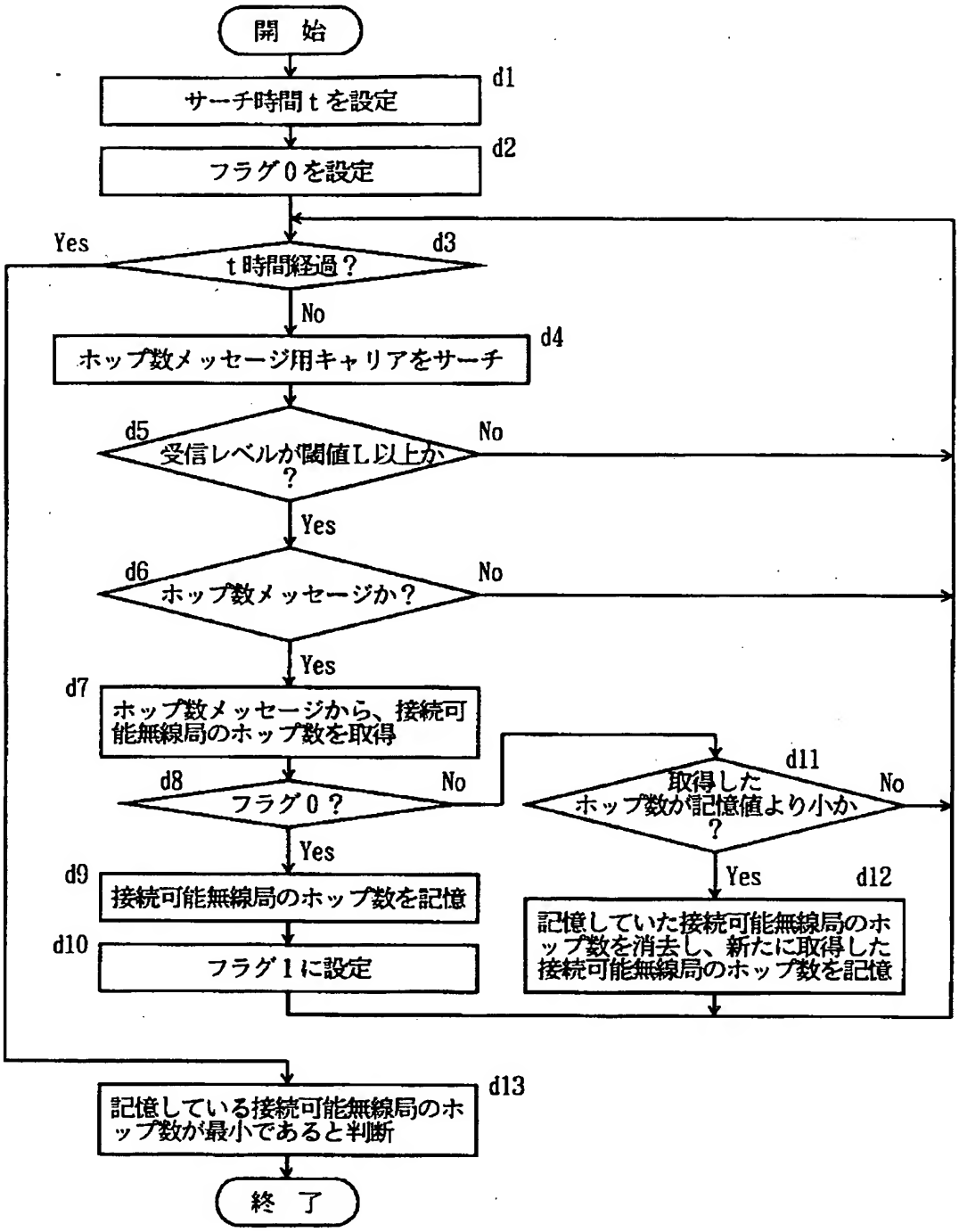


[Drawing 6]
基地局の通信エリア外の無線局から基地局まで信号が転送される様子



[Drawing 7]

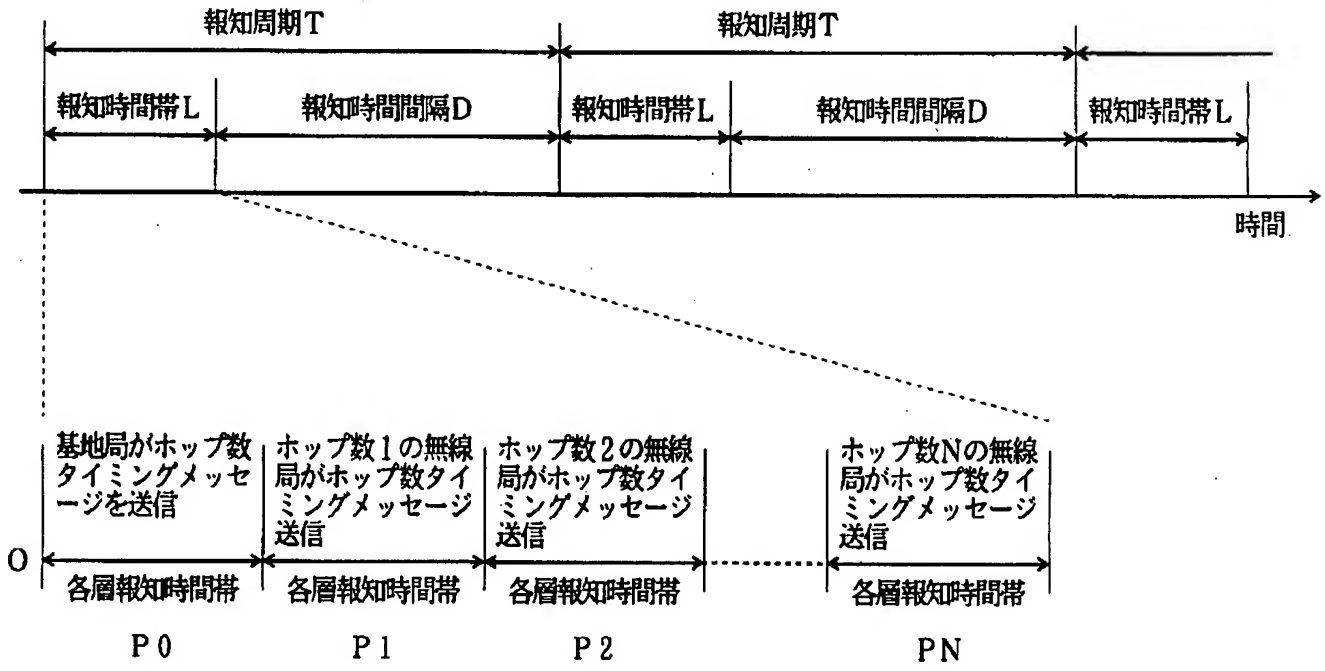
ホップ数情報取得手段11および上位接続先無線局選定手段12の処理手順の第１の実施形態



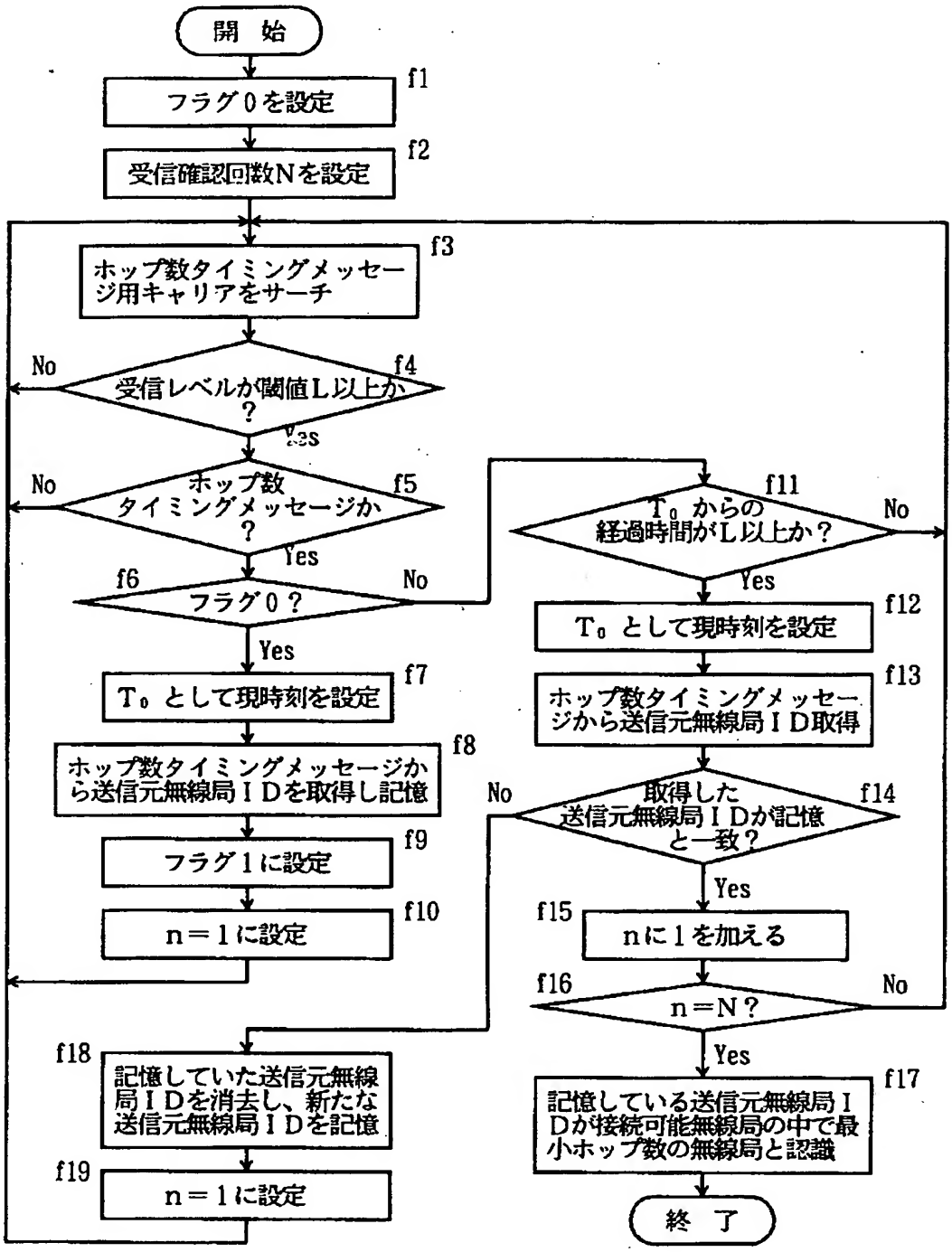
[Drawing 8]

[Drawing 9]

基地局および各無線局のホップ数タイミングメッセージを送信するタイミングの一例

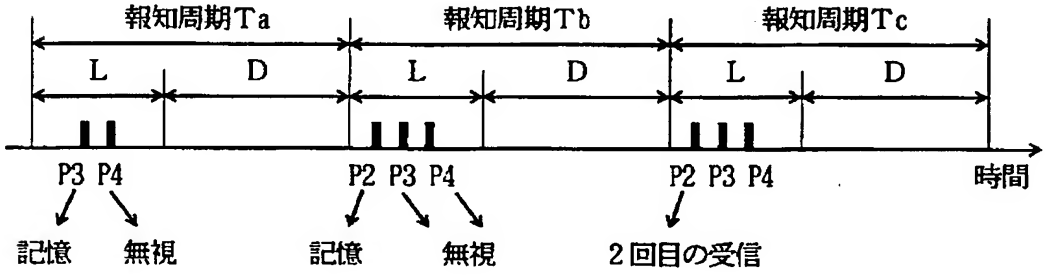


ホップ数情報取得手段11および上位接続先無線局選定手段12の処理手順の第２の実施形態



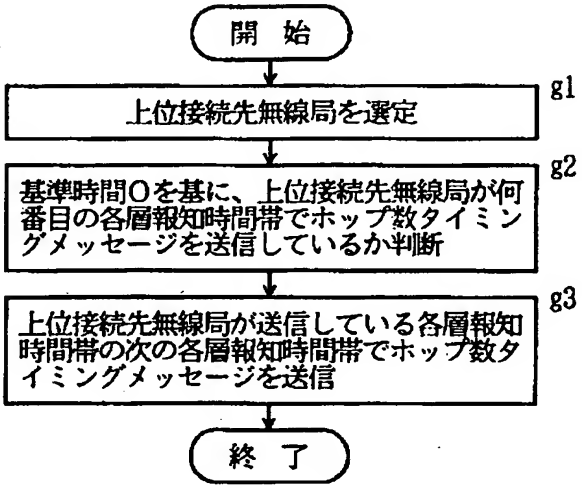
[Drawing 10]

第２の実施形態の具体的な動作例

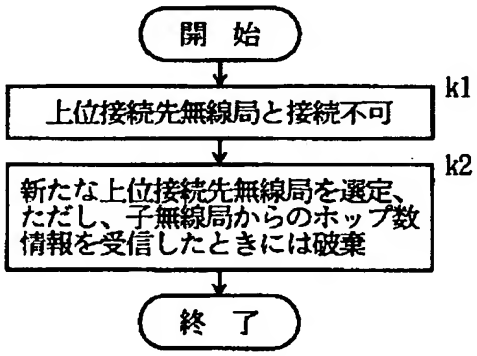


[Drawing 11]

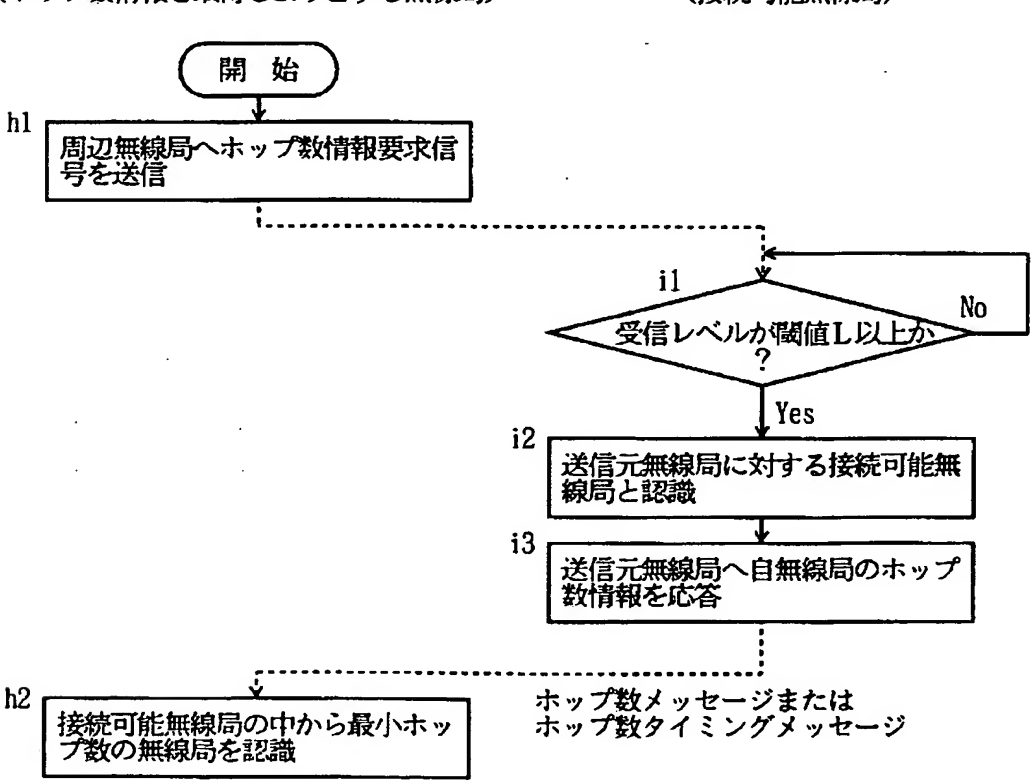
第２の実施形態におけるホップ数情報の送信処理手順



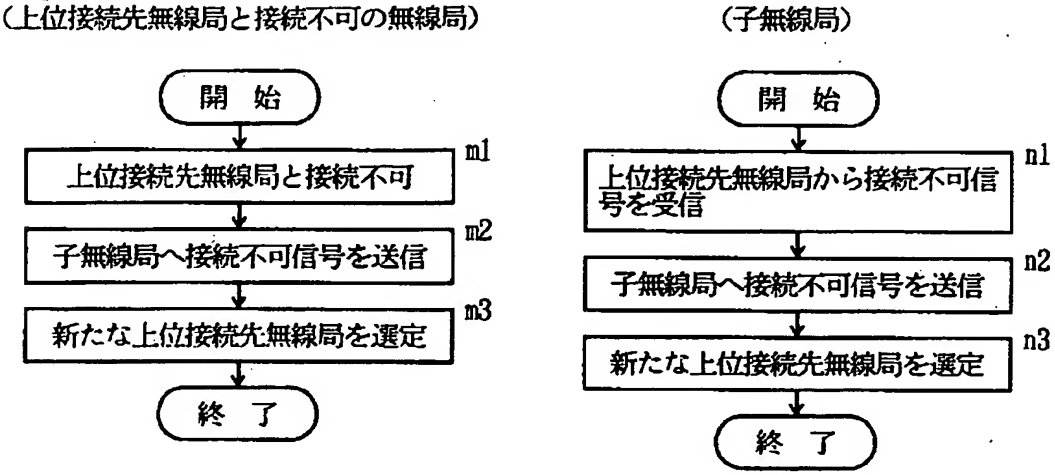
[Drawing 14]
ホップ数情報取得手段11および上位接続先無線局選定手段12の処理手順の第５の実施形態



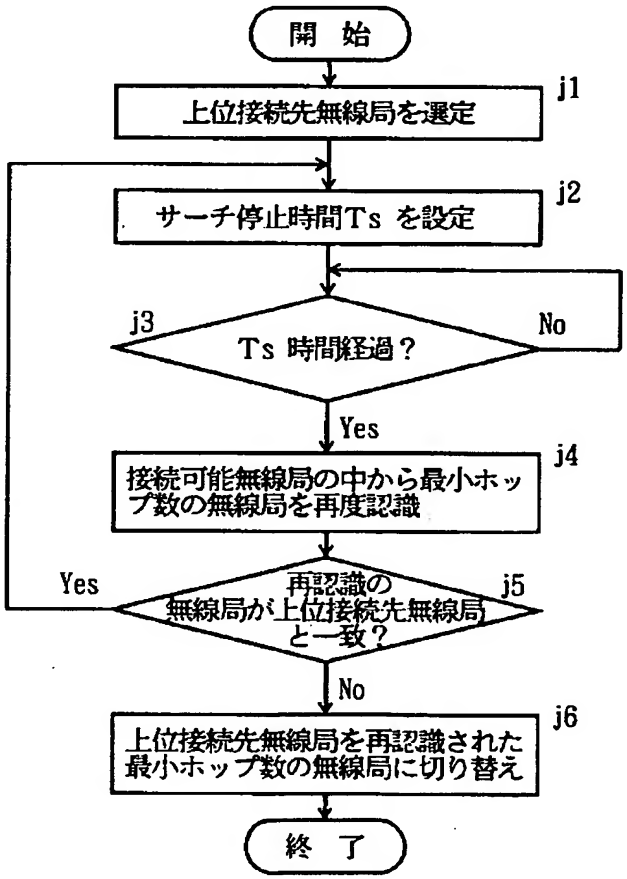
[Drawing 12]
ホップ数情報取得手段11および上位接続先無線局選定手段12の処理手順の第３の実施形態



[Drawing 15]
ホップ数情報取得手段11および上位接続先無線局選定手段12の処理手順の第６の実施形態

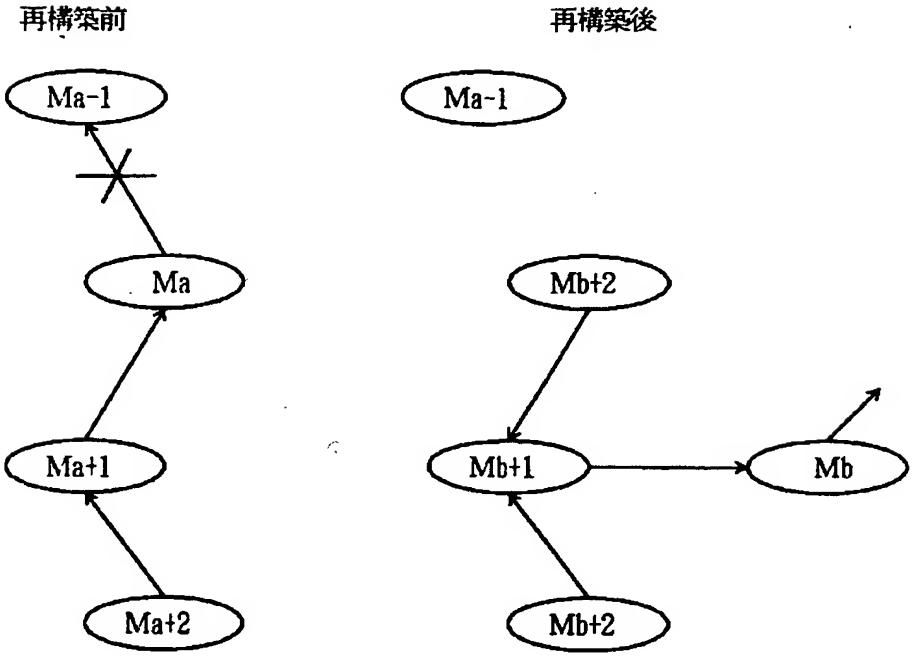


[Drawing 13]
ホップ数情報取得手段11および上位接続先無線局選定手段12の処理手順の第４の実施形態



[Drawing 16]

第６の実施形態の具体的な動作例



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12/44			３４０	５Ｋ０６７
12/56		11/20	１０２Ｄ	９Ａ００１

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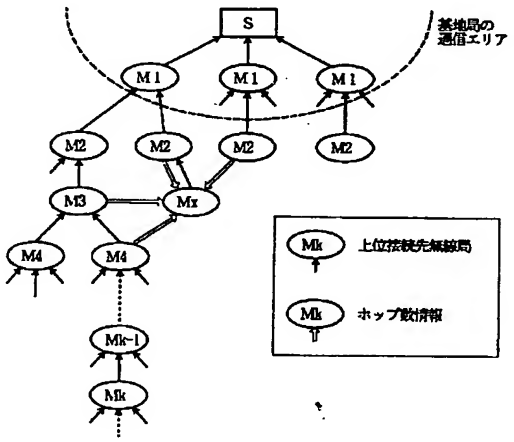
最終頁に続く

(54)【発明の名称】　マルチホップ無線ネットワークおよび無線局

(57)【要約】
【課題】　スター型マルチホップ無線ネットワークの構築に際して、各無線局が最適な接続先（上位接続先無線局）を見つけることにより各無線局が自律的に構築する。
【解決手段】　各無線局のホップ数情報取得手段が接続可能無線局からホップ数情報を取得し、上位接続先無線局選定手段が基地局に直接接続できる場合には基地局を上位接続先無線局として選定し、基地局に直接接続できない場合には接続可能無線局の中から、ホップ数情報により得られるホップ数が最小となる１つの接続可能無線局を上位接続先無線局として選定し、信号転送手段が送信信号または子無線局から受信した信号を上位接続先無線局へ、または基地局に直接接続できる場合は基地局へ転送する。

本発明の無線局によってマルチホップ無線ネットワークが構成される過程の一例



【特許請求の範囲】

【請求項１】　基地局と複数の無線局から構成され、各無線局が中継機能をもち、基地局の通信エリア外に存在する無線局が所定の無線局を中継して基地局と通信するマルチホップ無線ネットワークにおいて、

前記各無線局は、

直接接続できる他の無線局（以下「接続可能無線局」という）から、前記基地局までの中継無線局数（以下「ホップ数」という）に関するホップ数情報を取得するホップ数情報取得手段と、

前記基地局に直接接続できる場合には基地局を上位接続先無線局として選定し、前記基地局に直接接続できない場合には前記接続可能無線局の中から、前記ホップ数情報により得られるホップ数が最小となる１つの接続可能無線局を上位接続先無線局として選定する上位接続先無線局選定手段と、

送信信号または自無線局を上位接続先無線局と選定した下位の無線局（以下「子無線局」という）から受信した信号を前記上位接続先無線局へ、または前記基地局に直接接続できる場合は基地局へ転送する信号転送手段とを備え、前記各無線局が自律的に前記上位接続先無線局を選定し、前記基地局までの中継路を設定する構成であることを特徴とするマルチホップ無線ネットワーク。

【請求項２】　前記基地局と直接接続できる無線局のホップ数情報取得手段は、自無線局のホップ数を１と認識し、それ以外の無線局のホップ数情報取得手段は、前記上位接続先無線局選定手段が選定した上位接続先無線局のホップ数に１を加えたものを自無線局のホップ数として認識し、前記基地局側から前記中継路に沿って各無線局のホップ数を順に加算する構成であることを特徴とする請求項１に記載のマルチホップ無線ネットワーク。

【請求項３】　前記無線局のホップ数情報取得手段は、前記ホップ数情報として自無線局のホップ数を含む報知メッセージを常時、同報的に送信するとともに、この報知メッセージを受信して前記接続可能無線局のホップ数情報を取得する構成であることを特徴とする請求項１または請求項２に記載のマルチホップ無線ネットワーク。

【請求項４】　前記無線局のホップ数情報取得手段は、前記ホップ数情報として自無線局のホップ数に基づいた送信タイミングで報知メッセージを同報的に送信するとともに、この報知メッセージの受信タイミングによって前記接続可能無線局のホップ数情報を取得する構成であることを特徴とする請求項１または請求項２に記載のマルチホップ無線ネットワーク。

【請求項５】　前記無線局のホップ数情報取得手段は、前記接続可能無線局にそのホップ数情報を通知するように要求する信号を送信し、この要求信号を受信した接続可能無線局が自無線局のホップ数情報を応答する信号を要求した接続可能無線局へ送信し、この応答信号を受信した無線局が接続可能無線局のホップ数情報を取得する構成であることを特徴とする請求項１または請求項２に記載のマルチホップ無線ネットワーク。

【請求項６】　ネットワークに新たに参入する無線局のホップ数情報取得手段は、前記接続可能無線局からの前記報知メッセージを受信してそのホップ数情報を取得するか、前記接続可能無線局からの前記報知メッセージの受信タイミングによってそのホップ数情報を取得するか、前記接続可能無線局に要求信号を送信しそれに応じた応答信号を受信してそのホップ数情報を取得する構成であることを特徴とする請求項３～５のいずれかに記載のマルチホップ無線ネットワーク。

【請求項７】　前記無線局のホップ数情報取得手段および上位接続先無線局選定手段は、マルチホップ無線ネットワークを構築した後に、所定のタイミングで前記接続可能無線局の中から前記ホップ数が最小となる１つの接続可能無線局を選定し、その接続可能無線局と現在の上位接続先無線局が不一致の場合にはその接続可能無線局を新たな上位接続先無線局として選定する構成であることを特徴とする請求項１～６のいずれかに記載のマルチホップ無線ネットワーク。

【請求項８】　前記無線局のホップ数情報取得手段および上位接続先無線局選定手段は、マルチホップ無線ネットワークを構築した後に、前記上位接続先無線局と接続ができなくなった場合には、改めて前記接続可能無線局の中から前記子無線局を除いて前記ホップ数が最小となる１つの接続可能無線局を上位接続先無線局として選定する構成であることを特徴とする請求項１～６のいずれかに記載のマルチホップ無線ネットワーク。

【請求項９】　前記無線局のホップ数情報取得手段および上位接続先無線局選定手段は、マルチホップ無線ネットワークを構築した後に、前記上位接続先無線局と接続ができなくなった場合には、その旨を接続不可信号により前記子無線局に報知し、報知後に改めて前記接続可能無線局の中から前記ホップ数が最小となる１つの接続可能無線局を上位接続先無線局として選定し、また前記上位接続先無線局から前記接続不可信号を受信した無線局は、同様に子無線局へ接続不可信号を報知するとともに新たな上位接続先無線局を選定する構成であることを特徴とする請求項１～６のいずれかに記載のマルチホップ無線ネットワーク。

【請求項１０】　基地局と複数の無線局から構成され、各無線局が中継機能をもち、基地局の通信エリア外に存在する無線局が所定の無線局を中継して基地局と通信するマルチホップ無線ネットワークの無線局において、

前記接続可能無線局から前記ホップ数に関するホップ数情報を取得するホップ数情報取得手段と、

前記基地局に直接接続できる場合には基地局を上位接続先無線局として選定し、前記基地局に直接接続できない場合には前記接続可能無線局の中から、前記ホップ数情報により得られるホップ数が最小となる１つの接続可能

無線局を上位接続先無線局として選定する上位接続先無線局選定手段と、
送信信号または前記子無線局から受信した信号を前記上位接続先無線局へ、または前記基地局に直接接続できる場合は基地局へ転送する信号転送手段とを備えたことを特徴とするマルチホップ無線ネットワークの無線局。

【請求項１１】　前記基地局と直接接続できる無線局のホップ数情報取得手段は、自無線局のホップ数を１と認識し、それ以外の無線局のホップ数情報取得手段は、前記上位接続先無線局選定手段が選定した上位接続先無線局のホップ数に１を加えたものを自無線局のホップ数と認識する構成であることを特徴とする請求項１０に記載のマルチホップ無線ネットワークの無線局。

【請求項１２】　前記ホップ数情報取得手段は、前記ホップ数情報として自無線局のホップ数を含む報知メッセージを常時、同報的に送信するとともに、この報知メッセージを受信して前記接続可能無線局のホップ数情報を取得する構成であることを特徴とする請求項１０または請求項１１に記載のマルチホップ無線ネットワークの無線局。

【請求項１３】　前記ホップ数情報取得手段は、前記ホップ数情報として自無線局のホップ数に基づいた送信タイミングで報知メッセージを同報的に送信するとともに、この報知メッセージの受信タイミングによって前記接続可能無線局のホップ数情報を取得する構成であることを特徴とする請求項１０または請求項１１に記載のマルチホップ無線ネットワークの無線局。

【請求項１４】　前記ホップ数情報取得手段は、前記接続可能無線局にそのホップ数情報を通知するように要求する信号を送信し、この要求信号を受信した接続可能無線局が自無線局のホップ数情報を応答する信号を要求した接続可能無線局へ送信し、この応答信号を受信した無線局が接続可能無線局のホップ数情報を取得する構成であることを特徴とする請求項１０または請求項１１に記載のマルチホップ無線ネットワークの無線局。

【請求項１５】　ネットワークに新たに参入する無線局のホップ数情報取得手段は、前記接続可能無線局からの前記報知メッセージを受信してそのホップ数情報を取得するか、前記接続可能無線局からの前記報知メッセージの受信タイミングによってそのホップ数情報を取得するか、前記接続可能無線局に要求信号を送信しそれに応じた応答信号を受信してそのホップ数情報を取得する構成であることを特徴とする請求項１２～１４のいずれかに記載のマルチホップ無線ネットワークの無線局。

【請求項１６】　前記ホップ数情報取得手段および上位接続先無線局選定手段は、マルチホップ無線ネットワークを構築した後に、所定のタイミングで前記接続可能無線局の中から前記ホップ数が最小となる１つの接続可能無線局を選定し、その接続可能無線局と現在の上位接続先無線局が不一致の場合にはその接続可能無線局を新たな上位接続先無線局として選定する構成であることを特徴とする請求項１０～１５のいずれかに記載のマルチホップ無線ネットワークの無線局。

【請求項１７】　前記ホップ数情報取得手段および上位接続先無線局選定手段は、マルチホップ無線ネットワークを構築した後に、前記上位接続先無線局と接続ができなくなった場合には、改めて前記接続可能無線局の中から前記子無線局を除いて前記ホップ数が最小となる１つの接続可能無線局を上位接続先無線局として選定する構成であることを特徴とする請求項１０～１５のいずれかに記載のマルチホップ無線ネットワークの無線局。

【請求項１８】　前記ホップ数情報取得手段および上位接続先無線局選定手段は、マルチホップ無線ネットワークを構築した後に、前記上位接続先無線局と接続ができなくなった場合には、その旨を接続不可信号により前記子無線局に報知し、報知後に改めて前記接続可能無線局の中から前記ホップ数が最小となる１つの接続可能無線局を上位接続先無線局として選定し、また前記上位接続先無線局から前記接続不可信号を受信した無線局は、同様に子無線局へ接続不可信号を報知するとともに新たな上位接続先無線局を選定する構成であることを特徴とする請求項１０～１５のいずれかに記載のマルチホップ無線ネットワークの無線局。

【発明の詳細な説明】

【０００１】

【発明の属する技術分野】本発明は、移動体通信や無線ＬＡＮのような複数の無線局が同一の基地局にアクセスするスター型無線ネットワークの中で、各無線局が中継機能をもつことにより、基地局の通信エリア外に存在する無線局からも各無線局を中継して基地局にアクセスすることができるマルチホップ無線ネットワークに関する。

【０００２】特に、各無線局から基地局までの中継路を自律的に構築するマルチホップ無線ネットワークおよび無線局に関する。

【０００３】

【従来の技術】ＰＤＣやＰＨＳなどの移動体通信では、各無線局は通信網にアクセスするために、通信網に直接接続されている基地局に一旦アクセスする。これらのシステムは、複数の無線局が同一の基地局にアクセスするスター型無線ネットワークの構成をとり、各基地局の通信エリアがそのまま当該システムの通信サービス提供可能エリアになる。

【０００４】ここで、ＰＤＣの場合は、基地局の通信エリアが半径数ｋｍに及ぶため、少ない基地局で広範囲に通信サービスを提供できるが、ＰＨＳの場合は、基地局の通信エリアが数百ｍにとどまるため、広範囲の通信サービスを提供するためには数多くの基地局を配置する必要がある。また、今後は伝送速度の高速化の要求が高まるに伴い、移動体通信でも無線ＬＡＮなどのような高周

波数帯を使用する基地局の利用が考えられ、ＰＨＳの基地局よりもさらに送受信エリアが狭くなる可能性がある。

【０００５】このように基地局の通信エリアが小さなシステムでは、サービス提供エリアを広げる一つの手法として、無線局間でマルチホップ無線ネットワークを構成する方法がある。マルチホップ無線ネットワークとは、各無線局が中継機能をもち、互いに直接通信ができない無線局間をその間に存在する複数の無線局が信号を中継することにより、その無線局間同士が通信できるネットワーク形態である。

【０００６】このマルチホップ無線ネットワークを上記のスター型無線ネットワークに適用した場合、例えばある基地局の通信エリア外にいる無線局（以下「エリア外無線局」という）から送信された信号を中継機能をもった近くの無線局（以下「中継無線局」という）が受信すると、この中継無線局は受信した信号をより基地局に近い（以下「上位」という）中継無線局に転送し、この中継無線局は受信した信号をさらに上位の中継無線局に転送し、以下順次上位の中継無線局を介して基地局まで転送する。これにより、エリア外無線局から送信された信号を基地局が受信することができる。また、基地局から送信される信号も上記とまったく逆の経路を辿ってエリア外無線局が受信することができる。

【０００７】したがって、各無線局間でマルチホップ無線ネットワークを構成することにより、基地局の通信エリア外にいる無線局が基地局と通信を行うことが可能となる。これにより、無線ＬＡＮのような基地局の通信エリアが狭いシステムであっても、無線局間で自律的に基地局のサービス提供エリアを広げることが可能となる。

【０００８】一般のマルチホップ無線ネットワークでは、任意の無線局からの信号を送信先の無線局まで届けるために、送信元無線局と送信先無線局との間で中継路が確立されている必要がある。しかし、上記のスター型無線ネットワークでは、各無線局から送信された信号の送信先は必ず基地局であることから、各無線局が基地局までの中継路を確立していればよい。すなわち、各無線局が確立する中継路が１つだけであることから、各無線局が信号を中継転送する上位接続先無線局（中継無線局、基地局）を１つ定めれば十分である。言い換えると、各無線局が上位接続先無線局を一意に定めれば、任意の無線局からの信号は各無線局が上位接続先無線局に転送することにより、基地局まで転送されることになる。

【０００９】したがって、マルチホップ無線ネットワークを上記のスター型無線ネットワークに適用するためには、基地局－無線局間で基地局を最上位局とし、かつ各無線局が上位接続先無線局を一意に定めるような構造（以下「スター型マルチホップ無線ネットワーク」という）を構築すればよい。ここで、基地局を最上位局とするスター型マルチホップ無線ネットワークの構成例を図１に示す。図において、Ｓは基地局、Ｍは無線局であり、矢印は上位接続先無線局を示す。

【００１０】従来のスター型マルチホップ無線ネットワークの構築法としては、最上位局による集中制御的なものがある。これは、各無線局が自局から接続できる他の無線局のすべてを最上位局に通知し、最上位局が実現可能なすべてのスター型マルチホップ無線ネットワーク構成を把握し、その中から最適なスター型マルチホップ無線ネットワーク構成を選択し、各無線局へ接続先を指示する構築法である。

【００１１】

【発明が解決しようとする課題】このような集中制御的な構築法は、ある無線局が故障や移動などの原因により中継機能を担えなくなったときに再構築が必要になる。これには、故障や移動した無線局が中継機能を担えなくなった旨を最上位局が把握するために、まずその無線局と接続していた無線局が次々に最上位局までその旨を通知し、最上位局はこの通知を受けて改めてスター型マルチホップ無線ネットワークの再構築に伴う各無線局の最適な接続先無線局を定め、全無線局にそれを報知しなければならない。また、新たに無線局が加わる場合も同様の動作が必要になる。

【００１２】したがって、集中制御的な構築法では、ある無線局が故障や移動などの原因により中継できなくなった場合や、新たに無線局が加わった場合には、スター型マルチホップ無線ネットワークの再構築に要する時間が長くなり、即時にネットワーク構成の変更ができない問題があった。また、変更のための変更通知トラヒックや報知トラヒックなどの制御用トラヒックが増大する問題があった。

【００１３】本発明は、スター型マルチホップ無線ネットワークの構築を最上位局（基地局）がすべて制御するのではなく、各無線局が最適な接続先の無線局を見つけることにより各無線局が自律的に構築することができるマルチホップ無線ネットワークおよび無線局を提供することを目的とする。

【００１４】

【課題を解決するための手段】請求項１，２に記載の発明は、マルチホップ無線ネットワークの構築法を示す。すなわち、各無線局のホップ数情報取得手段が接続可能無線局からホップ数情報を取得し、上位接続先無線局選定手段が基地局に直接接続できる場合には基地局を上位接続先無線局として選定し、基地局に直接接続できない場合には接続可能無線局の中から、ホップ数情報により得られるホップ数が最小となる１つの接続可能無線局を上位接続先無線局として選定し、信号転送手段が送信信号または子無線局から受信した信号を上位接続先無線局へ、または基地局に直接接続できる場合は基地局へ転送することにより、各無線局がマルチホップ無線ネットワ

ークを自律的に構築することができる。

【００１５】なお、これは各無線局が自無線局のホップ数を予め認識していることを前提としているが、それが未定の場合には基地局に近い方から順に決めていく。すなわち、基地局と直接接続できる無線局のホップ数情報取得手段が自無線局のホップ数を１と設定し、それ以外の無線局のホップ数情報取得手段は上位接続先無線局選定手段が選定した上位接続先無線局のホップ数に１を加えたものを自無線局のホップ数として設定することにより、マルチホップ無線ネットワークを構成する各無線局のホップ数が基地局に近い方から順に決まる。そして、各無線局で１つの上位接続先無線局をそれぞれ選定することにより、各無線局がマルチホップ無線ネットワークを自律的に構築することができる。

【００１６】請求項３～５に記載の発明は、無線局のホップ数情報取得手段の構成を示す。すなわち、請求項３の無線局のホップ数情報取得手段は、ホップ数情報として自無線局のホップ数を含む報知メッセージを常時、同報的に送信するとともに、この報知メッセージを受信して接続可能無線局のホップ数情報を取得する構成である。

【００１７】請求項４の無線局のホップ数情報取得手段は、ホップ数情報として自無線局のホップ数に基づいた送信タイミングで報知メッセージを同報的に送信するとともに、この報知メッセージの受信タイミングによって接続可能無線局のホップ数情報を取得する構成である。

【００１８】請求項５の無線局のホップ数情報取得手段は、接続可能無線局にそのホップ数情報を通知するように要求する信号を送信し、この要求信号を受信した接続可能無線局が自無線局のホップ数情報を応答する信号を要求した接続可能無線局へ送信し、この応答信号を受信した無線局が接続可能無線局のホップ数情報を取得する構成である。

【００１９】上記いずれの構成によっても、ホップ数情報取得手段は接続可能無線局からそのホップ数情報を取得することができ、その中からホップ数が最小となる１つの接続可能無線局を上位接続先無線局として選定すれば、マルチホップ無線ネットワークが自律的に構築される。

【００２０】請求項６に記載の発明は、新規の無線局がマルチホップ無線ネットワークに参入する場合の構成を示す。その無線局のホップ数情報取得手段は、接続可能無線局からの報知メッセージを受信してそのホップ数情報を取得するか、接続可能無線局からの報知メッセージの受信タイミングによってそのホップ数情報を取得するか、接続可能無線局に要求信号を送信しそれに応じた応答信号を受信してそのホップ数情報を取得することにより、ホップ数が最小となる１つの接続可能無線局を上位接続先無線局として選定でき、マルチホップ無線ネットワークに加わることができる。

【００２１】請求項７～９に記載の発明は、マルチホップ無線ネットワークを再構築する場合の構成を示す。すなわち、請求項７の無線局のホップ数情報取得手段および上位接続先無線局選定手段は、マルチホップ無線ネットワークを構築した後に、所定のタイミングで接続可能無線局の中からホップ数が最小となる１つの接続可能無線局を選定し、その接続可能無線局と現在の上位接続先無線局が不一致の場合にはその接続可能無線局を新たな上位接続先無線局として選定する構成である。

【００２２】請求項８の無線局のホップ数情報取得手段および上位接続先無線局選定手段は、マルチホップ無線ネットワークを構築した後に、上位接続先無線局と接続ができなくなった場合には、改めて接続可能無線局の中から子無線局を除いてホップ数が最小となる１つの接続可能無線局を上位接続先無線局として選定する構成である。

【００２３】請求項９の無線局のホップ数情報取得手段および上位接続先無線局選定手段は、マルチホップ無線ネットワークを構築した後に、上位接続先無線局と接続ができなくなった場合には、その旨を接続不可信号により子無線局に報知し、報知後に改めて接続可能無線局の中からホップ数が最小となる１つの接続可能無線局を上位接続先無線局として選定し、また上位接続先無線局から接続不可信号を受信した無線局は、同様に子無線局へ接続不可信号を報知するとともに新たな上位接続先無線局を選定する構成である。

【００２４】請求項１０～１８に記載の発明は、請求項１～９に記載のマルチホップ無線ネットワークに対応する無線局の構成を示す。

【００２５】

【発明の実施の形態】（請求項１，２，１０，１１に記載の発明の実施形態）図２は、本発明のマルチホップ無線ネットワークを構成する無線局の実施形態を示す。図において、無線局は、接続可能無線局からホップ数情報を取得するホップ数情報取得手段１１と、このホップ数情報に応じて接続可能無線局の中から中継先となる上位接続先無線局を選定する上位接続先無線局選定手段１２と、送信信号または子無線局から受信した信号を上位接続先無線局または基地局へ転送する信号転送手段１３とを備える。

【００２６】図３は、上位接続先無線局選定手段１２の基本的な処理手順を示す。まず、無線局が基地局に直接接続できる場合には、基地局を上位接続先無線局として選定する（ａ１）。次に、基地局に直接接続できない場合には、ホップ数情報取得手段１１が取得した接続可能無線局のホップ数情報を入力し（ａ２）、各接続可能無線局のホップ数情報を比較してその中からホップ数が最小となる１つの接続可能無線局を上位接続先無線局として選定する（ａ３）。ここで選定された上位接続先無線局は信号転送手段１３に通知され、子無線局から受信し

た信号の転送先となる。

【００２７】また、上位接続先無線局が選定されると（ａ３）、そのホップ数に１を加えたものを自無線局のホップ数として認識し、そのホップ数情報を接続可能無線局のホップ数情報取得手段１１に通知する（ａ４）。ホップ数情報取得手段１１は、以下に説明する方法により接続可能無線局に対してそのホップ数情報を通知する。なお、基地局と直接接続できる無線局のホップ数情報取得手段１１は、自無線局のホップ数を１と認識し、それ以外の無線局のホップ数情報取得手段１１は、上位接続先無線局選定手段１２が選定した上位接続先無線局のホップ数に１を加えたものを自無線局のホップ数として認識する。また、基地局を１つの無線局として扱い、基地局のホップ数を０と定義してもよい。

【００２８】図４は、本発明の無線局によってマルチホップ無線ネットワークが構成される過程の一例を示す。図において、基地局Ｓに直接接続できる無線局Ｍ１のホップ数情報取得手段１１にはホップ数１が設定される。次に、この無線局Ｍ１が決まると、これを接続可能無線局とする無線局がそれぞれ上位接続先無線局として１つの無線局Ｍ１を選定することにより、各無線局Ｍ１に対してツリー状にホップ数２となる無線局Ｍ２が決定する。以下同様に、無線局Ｍ３、Ｍ４、…、Ｍｋが順次決まっていく。ここで、Ｍｋは、ホップ数がｋである無線局を示す。

【００２９】いま、無線局Ｍｘがネットワーク内に新たに参入してきたとする。無線局Ｍｘは、接続可能無線局である無線局Ｍ２，Ｍ３，Ｍ４の中からホップ数が最小となる１つの無線局Ｍ２を選択し、これを上位接続先無線局として選定する。これにより、無線局Ｍｘのホップ数は３となり、上位接続先無線局として１つの無線局Ｍ２に接続されることになる。このようにして、各無線局がそれぞれ上位接続先無線局を１局だけ定める。これにより、各無線局が上位接続先無線局に接続され、基地局と各無線局間に基地局を最上位局とするマルチホップ無線ネットワークが形成される。

【００３０】図５は、信号転送手段１３の基本的な処理手順を示す。図５(a) は、送信元無線局における信号転送手段１３の処理手順である。送信元無線局における信号転送手段１３は、基地局宛ての送信信号が発生すると（ｂ１）、その送信信号を上位接続先無線局へ送信する（ｂ２）。図５(b) は、中継無線局における信号転送手段１３の処理手順である。中継無線局における信号転送手段１３は、子無線局から信号を受信すると（ｃ１）、受信した信号を上位接続先無線局へ送信する（ｃ２）。

【００３１】このような無線局の信号転送手段１３の動作により、基地局の通信エリア外に存在している無線局から送信された信号も基地局まで転送することができる。この信号転送の様子を図６に示す。

【００３２】図６において、基地局Ｓの通信エリア外に存在している無線局Ｍｋが基地局宛てに信号を送信する場合には、まず上位接続先無線局である無線局Mk-1 に信号を送信する。この信号を受信した無線局Mk-1 は、同様に上位接続先無線局である無線局Mk-2 に受信信号を転送する。以下、各無線局はそれぞれ上位接続先無線局へ受信信号を転送し、最終的に無線局Ｍ１が基地局Ｓに受信信号を転送する。基地局Ｓから無線局Ｍｋへ信号を送信する場合には、この経路を逆に辿っていくことにより転送が可能である。

【００３３】以上の手順により、各無線局は上位接続先無線局を選定し、基地局を最上位局とするマルチホップ無線ネットワークを自律的に構築することができる。また、各無線局は、接続可能無線局の中から最小ホップ数の無線局を上位接続先無線局に選定しているので、ホップ数が最小となるマルチホップ無線ネットワークが自動的に構築される。また、各無線局が子無線局から受信した信号を上位接続先無線局へ転送することにより、基地局の通信エリア外に存在する無線局から送信した信号を１または複数の中継無線局を介して基地局まで転送する中継路を自動的に確立することができる。

【００３４】（請求項３，１２に記載の発明の実施形態）本実施形態は、各無線局のホップ数情報取得手段１１が、自無線局のホップ数を組み込んだ報知メッセージ（以下「ホップ数メッセージ」という）を同報的に送信し、またこのホップ数メッセージを受信して接続可能無線局のホップ数を取得するものである。なお、基地局も同様にホップ数メッセージを同報的に送信する場合には、基地局のホップ数を０と定義する。ホップ数メッセージ用のキャリアは、本ネットワーク内では予め定められているものとする。

【００３５】図７は、無線局のホップ数情報取得手段１１および上位接続先無線局選定手段１２の処理手順の第１の実施形態を示す。図において、各無線局のホップ数情報取得手段１１が接続可能無線局のホップ数を取得しようとする際には、まずホップ数メッセージのサーチ時間ｔを設定し（ｄ１）、初期状態を示すフラグ０を設定する（ｄ２）。

【００３６】次に、サーチ時間ｔを経過したか否かを監視しながら（ｄ３）、ホップ数メッセージ用キャリアをサーチし（ｄ４）、受信レベルが閾値Ｌ以上の信号が受信されたか否かを判断する（ｄ５）。受信レベルが閾値Ｌ以上の信号が受信された場合には、この信号を復調してホップ数メッセージであるか否かを判断する（ｄ６）。なお、この閾値Ｌは、自無線局がこの信号を送信する無線局と接続できるか否かを判断する判断基準であり、具体的には接続可能無線局を選択する最低受信レベルである。一方、受信レベルが閾値Ｌ未満の場合には、ホップ数メッセージ用キャリアのサーチ（ｄ３，ｄ４）に戻る。

【００３７】受信信号がホップ数メッセージである場合

には、それからホップ数と送信元無線局ＩＤを読み取り、接続可能無線局のホップ数を取得する（ｄ７）。一方、受信信号がホップ数メッセージでない場合には、再びホップ数メッセージ用キャリアのサーチ（ｄ３，ｄ４）に戻る。次に、取得した接続可能無線局のホップ数が最初であるか否かについて、フラグ０であるか否かを判断する（ｄ８）。最初はフラグ０であるので、取得した接続可能無線局のホップ数を記憶し（ｄ９）、フラグ１に設定（ｄ10）して再びホップ数メッセージ用キャリアのサーチ（ｄ３，ｄ４）に戻る。

【００３８】次のホップ数メッセージが受信された場合には、フラグ１によりｄ８でNo となり、既に記憶している接続可能無線局のホップ数と比較する（ｄ11）。新たに取得した接続可能無線局のホップ数が記憶しているホップ数より小さい場合には、記憶していた接続可能無線局のホップ数を消去し、新たに取得した接続可能無線局のホップ数を記憶する（ｄ12）。一方、新たに取得した接続可能無線局のホップ数が記憶しているホップ数より大きいか等しい場合には、記憶している接続可能無線局のホップ数をそのままにして再びホップ数メッセージ用キャリアのサーチ（ｄ３，ｄ４）に戻る。なお、新たに取得した接続可能無線局のホップ数が記憶しているホップ数と等しい場合には、新たに取得した接続可能無線局のホップ数に入れ替えてもよいし、受信レベルを比較して大きい方を選択して記憶するようにしてもよい。これにより、取得した接続可能無線局のホップ数の中で常に最小のものが記憶されることになる。

【００３９】また、サーチ中は、サーチ開始からサーチ時間ｔを越えたか否かを常に監視しているが（ｄ３）、サーチ時間ｔを経過していない場合にはホップ数メッセージ用キャリアのサーチを継続する（ｄ４）。一方、サーチ時間ｔを経過した場合には、ホップ数メッセージ用キャリアのサーチを終了とし、現時点で記憶している接続可能無線局のホップ数が最小であると判断する（ｄ13）。

【００４０】以上の処理により、各無線局は接続可能無線局のホップ数メッセージから取得したホップ数により、最小ホップ数の無線局を認識することができる。そして、この無線局を上位接続先無線局と選定する（図３のａ３）。接続可能無線局の中から１つの上位接続先無線局を選定できた無線局では、上位接続先無線局のホップ数に１を加えたものを自無線局のホップ数とし、そのホップ数を組み込んだホップ数メッセージを同報的に送信する（図３のａ４）。

【００４１】（請求項４，１３に記載の発明の実施形態）本実施形態は、各無線局のホップ数情報取得手段１１が、自無線局のホップ数に基づいた送信タイミングで報知メッセージ（以下「ホップ数タイミングメッセージ」という）を同報的に送信し、このホップ数タイミングメッセージの受信タイミングにより接続可能無線局のホップ数を認識するものである。なお、基地局も同様に所定の送信タイミングでホップ数タイミングメッセージを同報的に送信する場合には、基地局のホップ数を０と定義し、それに応じた送信タイミングが設定される。ホップ数タイミングメッセージ用のキャリアは、本ネットワーク内では予め定められているものとする。

【００４２】図８は、基地局および各無線局がホップ数タイミングメッセージを送信するタイミングの一例を示す。図において、時間軸は、基地局および各無線局がホップ数タイミングメッセージを送信する報知時間帯Ｌと、基地局および各無線局が一切ホップ数タイミングメッセージを送信しない報知時間間隔Ｄに分けられ、これを報知周期Ｔで繰り返す。ただし、報知時間間隔Ｄは報知時間帯Ｌよりも大きくとる必要がある。

【００４３】報知時間帯Ｌは、ホップ数が同じ無線局がホップ数タイミングメッセージを送信する各層報知時間帯に区分されている。例えば、最初の各層報知時間帯は、基地局だけがホップ数タイミングメッセージＰ０を送信でき、次の各層報知時間帯はホップ数１の無線局だけがホップ数タイミングメッセージＰ１を送信でき、以下同様に各層報知時間帯ごとにそれぞれホップ数２，３，…の無線局だけがホップ数タイミングメッセージＰ２，Ｐ３，…を送信できるものとする。基地局および各無線局は、それぞれのホップ数に対応する各層報知時間帯で報知周期Ｔごとにホップ数タイミングメッセージを送信する。

【００４４】図９は、無線局のホップ数情報取得手段１１および上位接続先無線局選定手段１２の処理手順の第２の実施形態を示す。図において、各無線局のホップ数情報取得手段１１が接続可能無線局のホップ数を取得しようとする際には、初期状態を示すフラグ０を設定し（ｆ１）、ホップ数タイミングメッセージの受信確認回数Ｎを設定する（ｆ２）。

【００４５】次に、ホップ数タイミングメッセージ用キャリアをサーチし（ｆ３）、受信レベルが閾値Ｌ以上の信号が受信されたか否かを判断する（ｆ４）。受信レベルが閾値Ｌ以上の信号が受信された場合には、この信号を復調してホップ数タイミングメッセージであるか否かを判断する（ｆ５）。なお、この閾値Ｌは、自無線局がこの信号を送信する無線局と接続できるか否かを判断する判断基準であり、具体的には接続可能無線局を選択する最低受信レベルである。一方、受信レベルが閾値Ｌ未満の場合、あるいは受信信号がホップ数タイミングメッセージでない場合には、ホップ数タイミングメッセージ用キャリアのサーチ（ｆ３）に戻る。

【００４６】受信信号がホップ数タイミングメッセージである場合には、フラグ０であるか否かを判断する（ｆ６）。最初はフラグ０であるので、ホップ数タイミングメッセージを最初に受信した時刻T_0として現時刻を設定し（ｆ７）、受信したホップ数タイミングメッセージ

から送信元無線局ＩＤを取得して記憶する（ｆ８）。次に、フラグ１に設定し（ｆ９）、さらに受信したホップ数タイミングメッセージが報知時間帯Ｌの中で最初に受信され、かつホップ数タイミングメッセージが初めて受信されたことを示すｎ＝１に設定し（ｆ10）、再びホップ数タイミングメッセージ用キャリアのサーチ（ｆ３）に戻る。

【００４７】次のホップ数タイミングメッセージが受信された場合には、フラグ１によりｆ６でNo となり、先に受信したホップ数タイミングメッセージの受信時刻T_0からの経過時間が、報知時間帯Ｌ以上であるか否かを判断する（ｆ11）。この経過時間がＬ以上でなければ（ｆ11でNo）、受信したホップ数タイミングメッセージが報知時間帯Ｌの中で最初に受信したものでないと判断し、その受信を無視して再びホップ数タイミングメッセージ用キャリアのサーチ（ｆ３）に戻る。一方、先の受信時刻T_0からの経過時間がＬ以上であれば（ｆ11でYes）、受信したホップ数タイミングメッセージが報知時間帯Ｌの中で最初の受信であると判断し、以下の処理を行う。

【００４８】まず、時刻T_0を現在時刻に再設定し（ｆ12）、受信したホップ数タイミングメッセージから送信元無線局ＩＤを取得し（ｆ13）、この送信元無線局ＩＤと記憶されている送信元無線局ＩＤが一致しているか否かを判断する（ｆ14）。両者が一致していた場合には、受信したホップ数タイミングメッセージは報知時間帯Ｌの中で最初に受信されたものであり、さらに前回のホップ数タイミングメッセージが今回の報知周期でも再度受信されたことになるので、ｎに１を加え（ｆ15）、ｎが確認回数Ｎに達したか否かを判断する（ｆ16）。ｎが確認回数Ｎに達していなければ、再びホップ数タイミングメッセージ用キャリアのサーチ（ｆ３）に戻る。一方、ｎが確認回数Ｎに達していれば、受信したホップ数タイミングメッセージが報知時間帯Ｌの中で最初に受信されたものであることが確定し、記憶している送信元無線局ＩＤが接続可能無線局の中で最小ホップ数の無線局であることを認識する（ｆ17）。

【００４９】また、送信元無線局ＩＤと記憶されている送信元無線局ＩＤが不一致の場合には（ｆ14でNo）、受信したホップ数タイミングメッセージが前回のものと異なり、前の報知時間帯Ｌの中で最初に受信されたホップ数タイミングメッセージと異なるタイミングで受信されたものと認識できる。したがって、記憶していた送信元無線局ＩＤを消去し、いま受信したホップ数タイミングメッセージから読み取った送信元無線局ＩＤを新たに記憶する（ｆ18）。その後、ｎ＝１に初期設定し（ｆ19）、再びホップ数タイミングメッセージ用キャリアのサーチ（ｆ３）に戻る。

【００５０】図１０は、第２の実施形態の具体的な動作例を示す。図において、最初の報知周期Ｔａでは、ホップ数３，４に対応するタイミングでホップ数タイミングメッセージＰ３，Ｐ４を連続して受信するが、Ｐ３は報知時間帯Ｌの中で最初に受信したものであり、その接続可能無線局を最小ホップ数の無線局として記憶する（ｆ８）。そして、続けて受信されるＰ４は、Ｐ３の受信時刻T_0から報知時間帯Ｌ以内であるので無視される（ｆ11でNo）。

【００５１】次に、Ｐ３の受信時刻T_0から報知時間帯Ｌ以上で受信されるホップ数タイミングメッセージを監視する。すなわち、次の報知周期Ｔｂでホップ数タイミングメッセージが受信されるか否かを監視し、ここではホップ数２に対応するホップ数タイミングメッセージＰ２が受信されるので、その接続可能無線局を最小ホップ数の無線局として記憶する（ｆ11でYes 、ｆ18）。報知周期Ｔｂにおけるｐ３，Ｐ４は無視される（ｆ11でNo）。

【００５２】次に、Ｐ２の受信時刻T_0から報知時間帯Ｌ以上で受信されるホップ数タイミングメッセージを監視する。すなわち、次の報知周期Ｔｃで、ホップ数タイミングメッセージが受信されるか否かを監視し、ここではＰ２が再度受信される（ｆ11でYes 、ｆ14でYes ）。このＰ２が同様にしてＮ回受信されたときに、Ｐ２を送信した接続可能無線局を最小ホップ数の無線局として確定する（ｆ17）。

【００５３】以上の処理により、各無線局はホップ数タイミングメッセージの受信タイミングを監視し、接続可能無線局の中から報知時間帯Ｌの中で最初に送信した無線局、すなわちホップ数が最小の無線局を認識することができる。また、確認回数を設けることにより、報知時間帯の中で最初にホップ数タイミングメッセージを送信した無線局を複数回に渡って確認することができる。そして、この無線局を上位接続先無線局と選定する（図３のａ３）。

【００５４】接続可能無線局の中から１つの上位接続先無線局を選定できた無線局では、上位接続先無線局のホップ数に１を加えたものを自無線局のホップ数とし、そのホップ数に対応する送信タイミングでホップ数タイミングメッセージを同報的に送信する（図３のａ４）。この具体的な処理手順について図１１を参照して説明する。

【００５５】図１１において、各無線局が上位接続先無線局を選定すると（ｇ１）、基準時間Ｏを基に、上位接続先無線局が何番目の各層報知時間帯でホップ数タイミングメッセージを送信しているか判断する（ｇ２）。この判断は、各無線局が各層報知時間帯の時間長を予め認識していれば、上位接続先無線局からのホップ数タイミングメッセージを受信した時間が基準時間Ｏから測ってその時間長の何倍であるかを計算することにより可能である。上位接続先無線局がホップ数タイミングメッセージを送信している各層報知時間帯が分かれば、その次の

各層報知時間帯で自無線局のホップ数タイミングメッセージを送信する（ｇ３）。

【００５６】なお、同じ各層報知時間帯でホップ数タイミングメッセージを送信する無線局が複数ある場合には、キャリアセンスなどにより他の無線局から送信されていないタイミングで自無線局のホップ数タイミングメッセージを送信する。これにより、各無線局は、そのホップ数に対応する送信タイミング（各層報知時間帯）でホップ数タイミングメッセージを送信し、接続可能無線局に対してホップ数に相当する情報を通知することができる。

【００５７】本実施形態は、各無線局が報知メッセージの送信タイミングを調整するだけで、各無線局が接続可能無線局の中から最小ホップ数の無線局を認識することできる。したがって、報知メッセージの中にホップ数を組み込むことができない場合でも、各無線局が報知メッセージの基準時間Ｏを認識できる通信システムであれば適用することができる。例えば、ＰＨＳなどのように、予め既存の報知メッセージによって各無線局の同期がとれているような通信システムに適用できる。

【００５８】（請求項５，１４に記載の発明の実施形態）本実施形態は、各無線局のホップ数情報取得手段１１が、接続可能無線局にそのホップ数情報（ホップ数メッセージ、ホップ数タイミングメッセージ）を通知するように要求する信号を送信し、この要求信号を受信した接続可能無線局が自無線局のホップ数情報を応答する信号を要求した接続可能無線局へ送信し、この応答信号を受信した無線局が接続可能無線局のホップ数情報を取得するものである。

【００５９】図１２は、本発明の無線局のホップ数情報取得手段１１および上位接続先無線局選定手段１２の処理手順の第３の実施形態を示す。図において、各無線局のホップ数情報取得手段１１が接続可能無線局のホップ数情報を取得しようとする際には、まず周辺無線局へ向けてホップ数情報要求信号を同報的に送信する（ｈ１）。このホップ数情報要求信号を受信した周辺無線局は、受信レベルが閾値Ｌ以上で受信されるか否かを判断する（ｉ１）。受信レベルが閾値Ｌ以上でホップ数情報要求信号を受信した無線局は、送信元無線局に対する接続可能無線局となる（ｉ２）。なお、この閾値Ｌは、自無線局がこの信号を送信する無線局と接続できるか否かを判断する判断基準であり、具体的には接続可能無線局を選択する最低受信レベルである。

【００６０】接続可能無線局のホップ数情報取得手段１１は、送信元無線局に対して自無線局のホップ数情報を通知する応答信号を送信する（ｉ３）。なお、この応答信号は、ホップ数を組み込んだホップ数メッセージでもよいし、ホップ数に対応する送信タイミングで送信されるホップ数タイミングメッセージでもよい。

【００６１】ホップ数情報要求信号を送信した無線局のホップ数情報取得手段１１は、この応答信号を受信することにより、上記第１の実施形態または第２の実施形態に示す構成により、接続可能無線局の中から最小ホップ数の無線局を認識する（ｈ２）。

【００６２】以上の処理により、各無線局は接続可能無線局の中からホップ数が最小の無線局を認識することができる。そして、この無線局を上位接続先無線局と選定する（図３のａ３）。接続可能無線局の中から１つの上位接続先無線局を選定できた無線局では、上位接続先無線局のホップ数に１を加えたものを自無線局のホップ数として認識し、ホップ数情報要求信号に応じて接続可能無線局がそのホップ数情報を同報的に応答する（図３のａ４）。

【００６３】本実施形態では、各無線局がホップ数情報要求信号を受信したときのみ、ホップ数を知らせるメッセージを送信する。したがって、上記第１の実施形態または第２の実施形態のように、常時同報的にホップ数情報を知らせる信号を送信する必要がないので、トラヒックを抑えることが可能となる。

【００６４】以上示した無線局のホップ数情報取得手段１１および上位接続先無線局選定手段１２の処理手順の実施形態は、マルチホップ無線ネットワーク内に新たに参入した新規無線局が、接続可能無線局のホップ数情報を取得しようとする際に適用することができる（請求項６，１５）。これにより、新規無線局に対する上位接続先無線局が決まり、マルチホップ無線ネットワークへの参入が可能となる。また、マルチホップ無線ネットワークを構築した後に、所定のタイミングで各無線局が接続可能無線局のホップ数情報を取得しようとする際に適用してもよい。これにより、マルチホップ無線ネットワークの再構築が可能となる。以下、マルチホップ無線ネットワークの再構築における特徴的な処理手順について説明する。

【００６５】（請求項７，１６に記載の発明の実施形態）図１３は、本発明の無線局のホップ数情報取得手段１１および上位接続先無線局選定手段１２の処理手順の第４の実施形態を示す。図において、各無線局が上位接続先無線局を選定した後に（ｊ１）、ホップ数情報取得手段１１が接続可能無線局の中からホップ数が最小となる無線局を再度認識する時間として、サーチ停止時間Ｔｓを設定する（ｊ２）。次に、サーチ停止時間Ｔｓが経過すると（ｊ３）、接続可能無線局の中からホップ数が最小となる無線局を再度認識する（ｊ４）。そして、再認識された最小ホップ数の無線局が、現在の上位接続先無線局と一致するか否かを判定する（ｊ５）。両者が一致している場合には、上位接続先無線局は変更せず、再びサーチ停止時間Ｔｓの設定に戻る（ｊ２）。

【００６６】一方、再認識された最小ホップ数の無線局と現在の上位接続先無線局が不一致の場合には、上位接続先無線局よりもホップ数が少ない接続可能無線局が出

現したことになり、上位接続先無線局を再認識された最小ホップ数の無線局に切り替える（ｊ６）。

【００６７】なお、接続可能無線局の中から最小ホップ数の無線局を再認識する方法は、上記第１の実施形態～第３の実施形態に示した処理手順を採用する。また、上記第１の実施形態または第３の実施形態に示した処理手順を採用した場合には、再認識された最小ホップ数の無線局のホップ数と、現在の上位接続先無線局のホップ数を比較し、前者が小さい場合に上位接続先無線局を再認識された最小ホップ数の無線局に切り替えてもよい。

【００６８】以上の処理により、各無線局は上位接続先無線局として常に接続可能無線局の中で最小ホップ数の無線局を選定することができる。したがって、本ネットワーク内に新規無線局が参入したときに、仮に新規無線局のホップ数が自無線局の上位接続先無線局のホップ数より小さい場合には、この無線局は自律的に上位接続先無線局を新規無線局に切り替えることができる。このように、本ネットワーク内に新規無線局が参入した場合や、無線局の移動などにって上位接続先無線局が変わるような場合でも、同様にホップ数最小のスター型マルチホップ無線ネットワークを再構築することができる。

【００６９】（請求項８，１７に記載の発明の実施形態）本実施形態は、マルチホップ無線ネットワークを構築後に、自無線局の移動や上位接続先無線局の移動や故障により、上位接続先無線局と接続できなくなった無線局において、新たな上位接続先無線局を選定することによりマルチホップ無線ネットワークの再構築を行うものである。なお、本実施形態では、各無線局が子無線局を認識しているものとする。具体的な認識方法としては、各無線局が上位接続先無線局を設定したときに、その旨を上位接続先無線局に知らせる方法や、子無線局からの信号を受信するときに子無線局を確認する方法などがある。

【００７０】図１４は、本発明の無線局のホップ数情報取得手段１１および上位接続先無線局選定手段１２の処理手順の第５の実施形態を示す。図において、各無線局が上位接続先無線局を選定した後に、自無線局の移動や上位接続先無線局の移動や故障により上位接続先無線局と接続できなくなった場合には（ｋ１）、この無線局は新たに上位接続先無線局を選定する（ｋ２）。なお、無線局が上位接続先無線局と接続できなくなることを認識する方法は、上位接続先無線局からの報知メッセージが受信できないことや、通信信号を上位接続先無線局に送信したときにその応答信号が返ってこないことを認識すればよい。また、無線局が上位接続先無線局を選定する際には、上記各実施形態に示した方法をとることができる。ただし、子無線局からのホップ数情報を受信したときにはこれを破棄する（ｋ２）。

【００７１】以上の処理により、上位接続先無線局の移動や故障などによって上位接続先無線局と接続できなくなった無線局は、子無線局を除いて上位接続先無線局を選定し、マルチホップ無線ネットワークの再構築を行うことができる。これにより、子無線局を上位接続先無線局として選定することによる生じる自無線局と子無線局間のループを回避することができる。また、各無線局は、さらに子無線局（以下「孫無線局」という）を新たな上位接続先無線局として選定することも考えられるが、接続可能無線局の中で最小ホップ数の無線局を上位接続先無線局と選定する本発明の構成では、自無線局と孫無線局は接続不可能でありその心配はない。すなわち、本実施形態では、各無線局が上位接続先無線局と接続できなくなっても、ループを防ぎながら新たな上位接続先無線局を選定し、正常な無線局間で自律的にマルチホップ無線ネットワークの再構築を行うことができる。

【００７２】（請求項９，１８に記載の発明の実施形態）本実施形態は、マルチホップ無線ネットワークを構築後に、自無線局の移動や上位接続先無線局の移動や故障により、上位接続先無線局と接続できなくなった無線局において、新たな上位接続先無線局を選定することによりマルチホップ無線ネットワークの再構築を行うものである。なお、本実施形態では、各無線局が子無線局を認識しているものとする。

【００７３】図１５は、本発明の無線局のホップ数情報取得手段１１および上位接続先無線局選定手段１２の処理手順の第６の実施形態を示す。図１５(a) は上位接続先無線局と接続不可になった無線局の処理手順であり、図１５(b) は子無線局の処理手順である。

【００７４】図において、各無線局が上位接続先無線局を選定した後に、自無線局の移動や上位接続先無線局の移動や故障により上位接続先無線局と接続できなくなった場合には（ｍ１）、この無線局は子無線局に対して自無線局が上位接続先無線局と接続できなくなった旨の接続不可信号を送信する（ｍ２）。そして、新たに上位接続先無線局を選定する（ｍ３）。

【００７５】一方、子無線局が、上位接続先無線局から接続不可信号を受信すると（ｎ１）、同様にその子無線局に対して自無線局が上位接続先無線局と接続できなくなった旨の接続不可信号を送信する（ｎ２）。そして、新たに上位接続先無線局を選定する（ｎ３）。以下同様にして、上位接続先無線局から接続不可信号を受信した無線局は、その子無線局に対して接続不可信号を送信するとともに、新たな上位接続先無線局の選定を行う。なお、無線局が上位接続先無線局を選定する際には、上記各実施形態に示した方法をとることができる。

【００７６】以上の処理により、無線局が上位接続先無線局の移動や故障などによって上位接続先無線局と接続できなくなった場合には、自無線局とともに、その子無線局、さらにその子無線局というように、自無線局の配下にあるすべての無線局が新たな上位接続先無線局を選定する処理を行う。これにより、マルチホップ無線ネッ

トワークの再構築を行うことができる。

【００７７】図１６は、第６の実施形態の具体的な動作例を示す。図において、当初のマルチホップ無線ネットワークは、無線局Ma-1 ，Ｍａ，Ma+1 ，Ma+2 が順に接続されていたとする。ここで、無線局Ma-1 と無線局Ｍａが接続できなくなったとする。無線局Ｍａが無線局Ma-1 と接続できなくなると、無線局Ｍａおよびその配下にある無線局Ma+1 ，Ma+2 も新たに上位接続先無線局を選定する。その結果、無線局Ｍａ，Ma+2 は新たな上位接続先無線局を選定することができず、無線局Ma+1 のみが新たな上位接続先無線局Ｍｂを選定できたとする。このとき、無線局Ma+1 のホップ数はｂ＋１となり、Mb+1 と表記される。そして、無線局Ｍａ，Ma+2 がそれぞれ新たな上位接続先無線局として無線局Mb+1 を選定することにより、無線局Mb+2 としてマルチホップ無線ネットワークが再構築される。

【００７８】このように、上位接続先無線局と接続できなくなった無線局だけが上位接続先無線局を新たに選定するだけでなく、その配下にあるすべての無線局で上位接続先無線局の選定をやり直すことにより、マルチホップ無線ネットワークのダイナミックな再構築が可能となる。

【００７９】

【発明の効果】以上説明したように、本発明のマルチホップ無線ネットワークおよび無線局は、接続可能無線局のホップ数情報を取得し（請求項３～６，１２～１５）、接続可能無線局の中からホップ数が最小となる１つの無線局を上位接続先無線局と選定する（請求項１，１０）。また、上位接続先無線局を選定したときに、そのホップ数に１を加えたものを自無線局のホップ数とし、各接続可能無線局に対してホップ数情報を通知する（請求項２，１１）。これにより、各無線局は自律的に上位接続先無線局を選定することができるので、ホップ数最小のマルチホップ無線ネットワークを自律的に構築することができる。

【００８０】また、各無線局が接続可能無線局の中で最小ホップ数の無線局を常に上位接続先無線局として選定することにより（請求項７，１６）、マルチホップ無線ネットワークの構築後に新たに参入する無線局があったり、無線局の移動などにって上位接続先無線局が変わるような場合でも、速やかにマルチホップ無線ネットワークの再構築を行うことができる。また、無線局が移動や故障などによりネットワークから離脱する場合には、この無線局を上位接続先無線局としていた無線局がループ構造を回避しながら新たな上位接続先無線局を自律的に選定することにより（請求項８，１７）、ループ構造が発生しないマルチホップ無線ネットワークを再構築することができる。また、離脱した無線局を上位接続先無線局としていた無線局だけでなく、その配下の無線局すべてが新たに上位接続先無線局を自律的に選定することにより（請求項９，１８）、ダイナミックにマルチホップ無線ネットワークの再構築が可能になる。したがって、無線局の離脱に対するマルチホップ無線ネットワークの再構築のロバスト性を高めることができる。

【００８１】以上により、本発明のマルチホップ無線ネットワークおよび無線局では、無線局の参入あるいは離脱にかかわらず、常に自律的に最小ホップ数の基地局を最上位局とするスター型マルチホップ無線ネットワークを構築することができる。

【図面の簡単な説明】

【図１】スター型マルチホップ無線ネットワークの構成例を示す図。

【図２】本発明のマルチホップ無線ネットワークを構成する無線局の実施形態を示すブロック図。

【図３】上位接続先無線局選定手段１２の基本的な処理手順を示すフローチャート。

【図４】本発明の無線局によってマルチホップ無線ネットワークが構成される過程の一例を示す図。

【図５】信号転送手段１３の基本的な処理手順を示すフローチャート。

【図６】基地局の通信エリア外の無線局から基地局まで信号が転送される様子を示す図。

【図７】ホップ数情報取得手段１１および上位接続先無線局選定手段１２の処理手順の第１の実施形態を示すフローチャート。

【図８】基地局および各無線局のホップ数タイミングメッセージを送信するタイミングの一例。

【図９】ホップ数情報取得手段１１および上位接続先無線局選定手段１２の処理手順の第２の実施形態を示すフローチャート。

【図１０】第２の実施形態の具体的な動作を示す図。

【図１１】第２の実施形態におけるホップ数情報の送信処理手順を示すフローチャート。

【図１２】ホップ数情報取得手段１１および上位接続先無線局選定手段１２の処理手順の第３の実施形態を示すフローチャート。

【図１３】ホップ数情報取得手段１１および上位接続先無線局選定手段１２の処理手順の第４の実施形態を示すフローチャート。

【図１４】ホップ数情報取得手段１１および上位接続先無線局選定手段１２の処理手順の第５の実施形態を示すフローチャート。

【図１５】ホップ数情報取得手段１１および上位接続先無線局選定手段１２の処理手順の第６の実施形態を示すフローチャート。

【図１６】第６の実施形態の具体的な動作例を示す図。

【符号の説明】

Ｓ　基地局

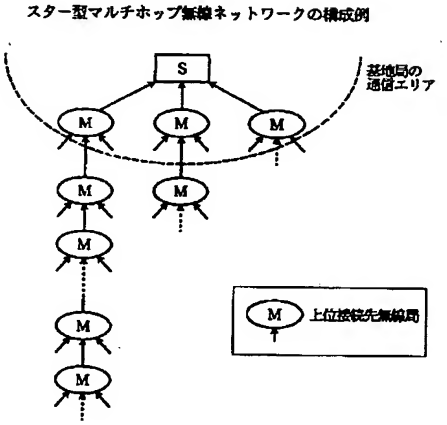
Ｍ　無線局

１１　ホップ数情報取得手段

１２　上位接続先無線局選定手段

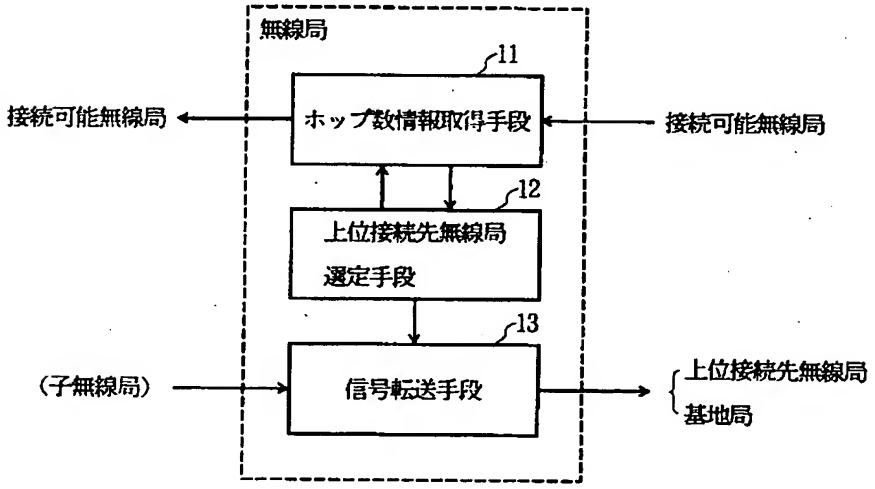
１３　信号転送手段

【図１】



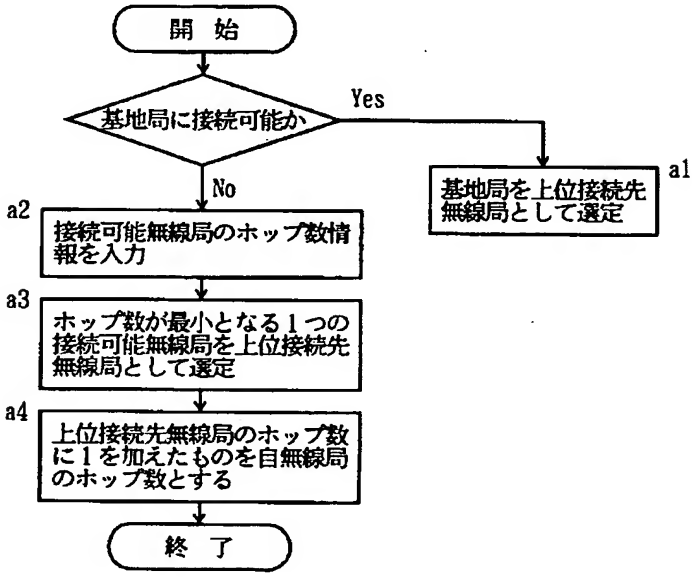
【図２】

本発明のマルチホップ無線ネットワークを構成する無線局の実施形態



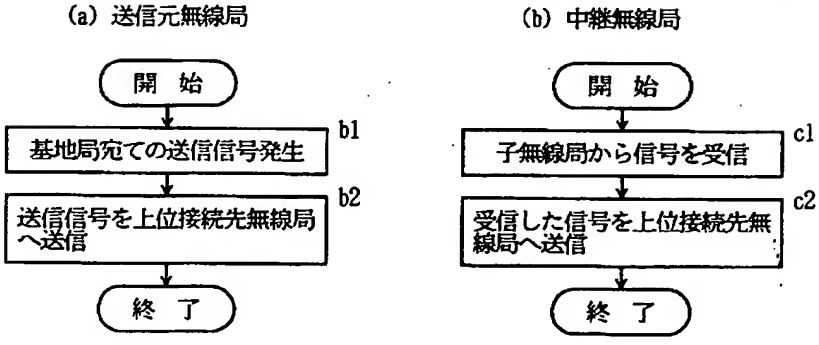
【図３】

上位接続先無線局選定手段12の基本的な処理手順



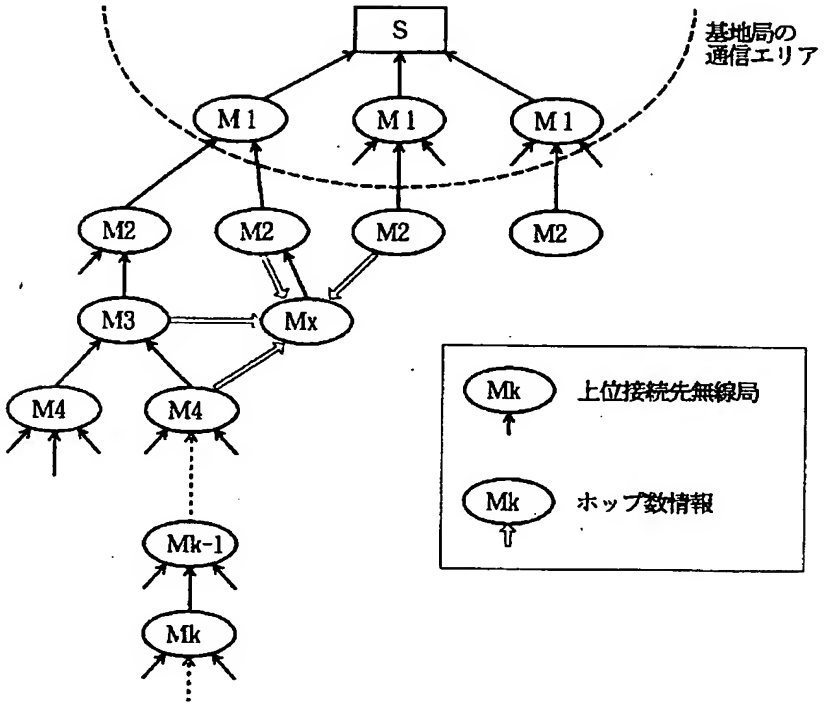
【図５】

信号転送手段13の基本的な処理手順



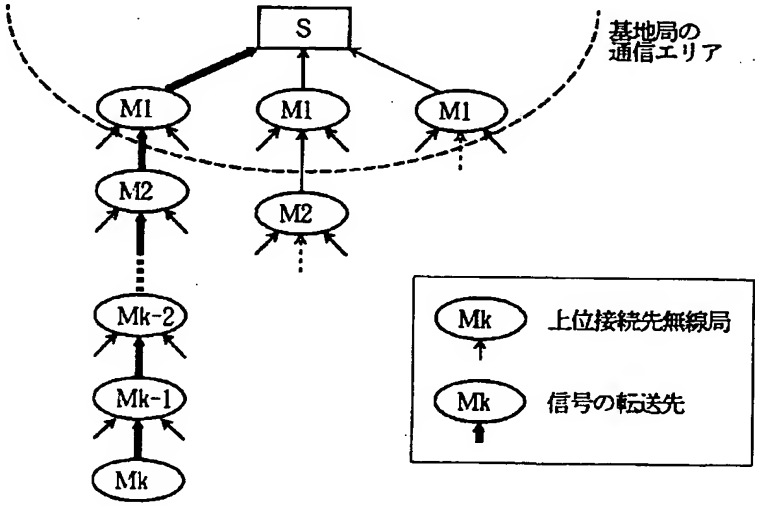
【図４】

本発明の無線局によってマルチホップ無線ネットワークが構成される過程の一例



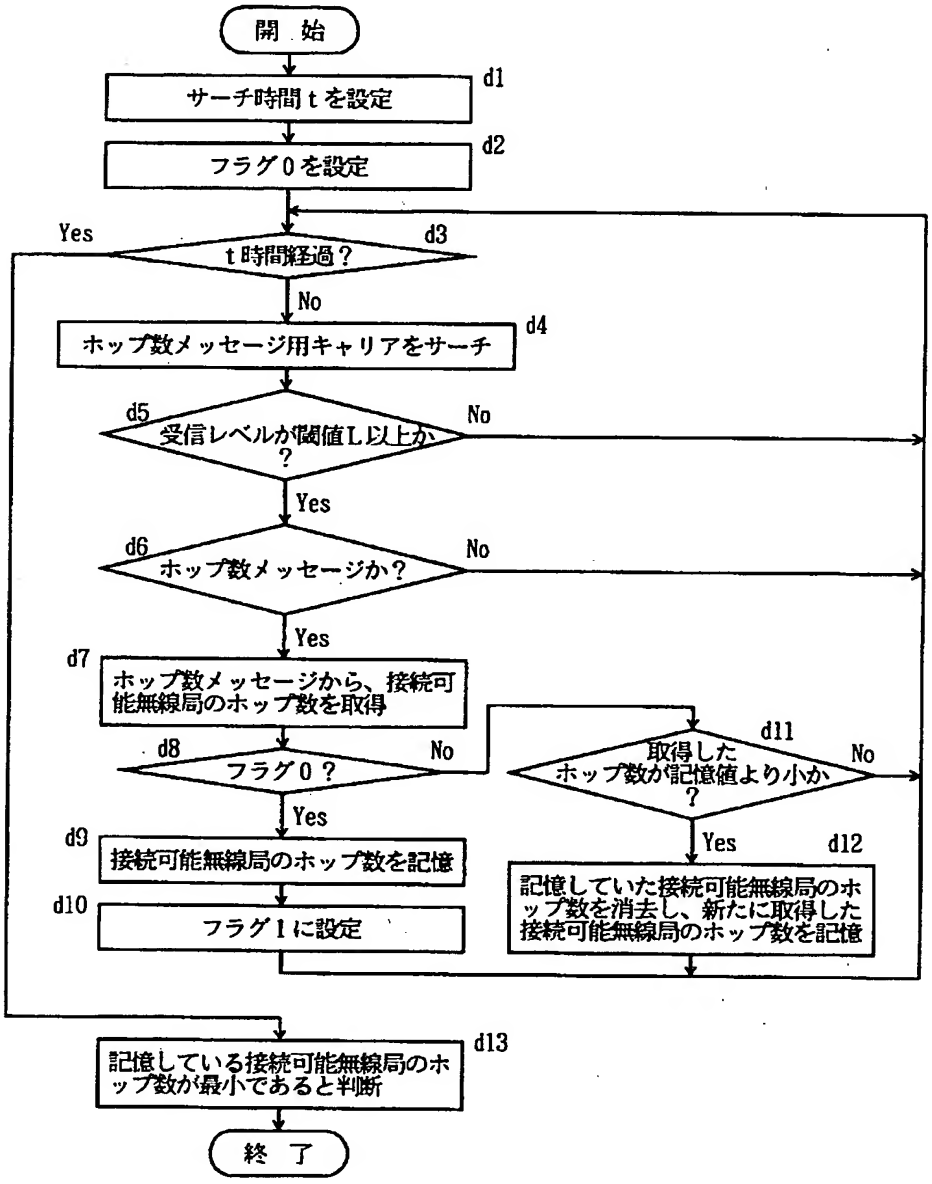
【図６】

基地局の通信エリア外の無線局から基地局まで信号が転送される様子



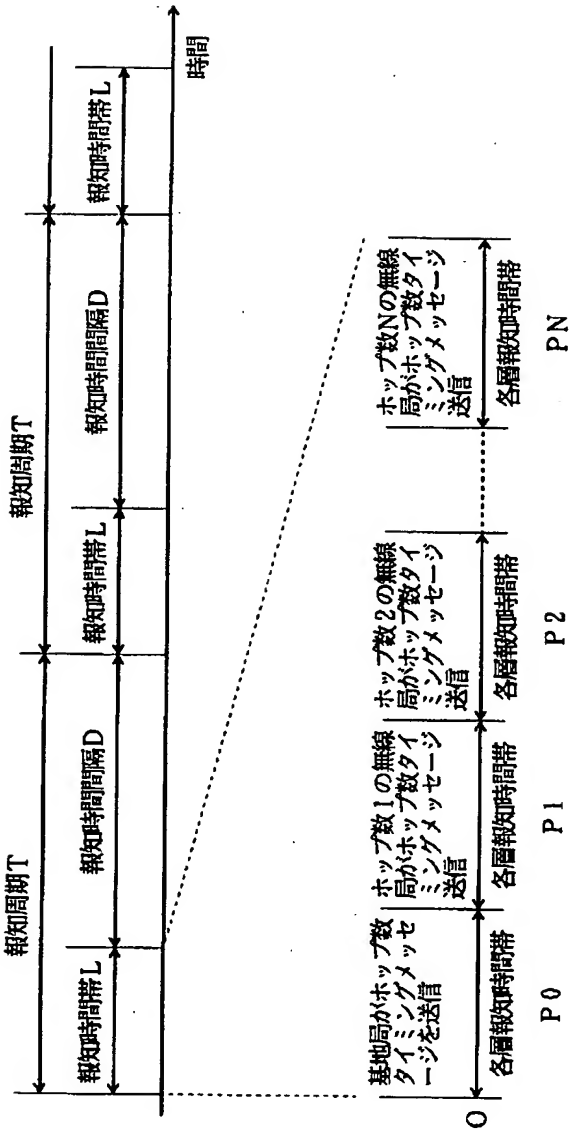
【図７】

ホップ数情報取得手段11および上位接続先無線局選定手段12の処理手順の第１の実施形態



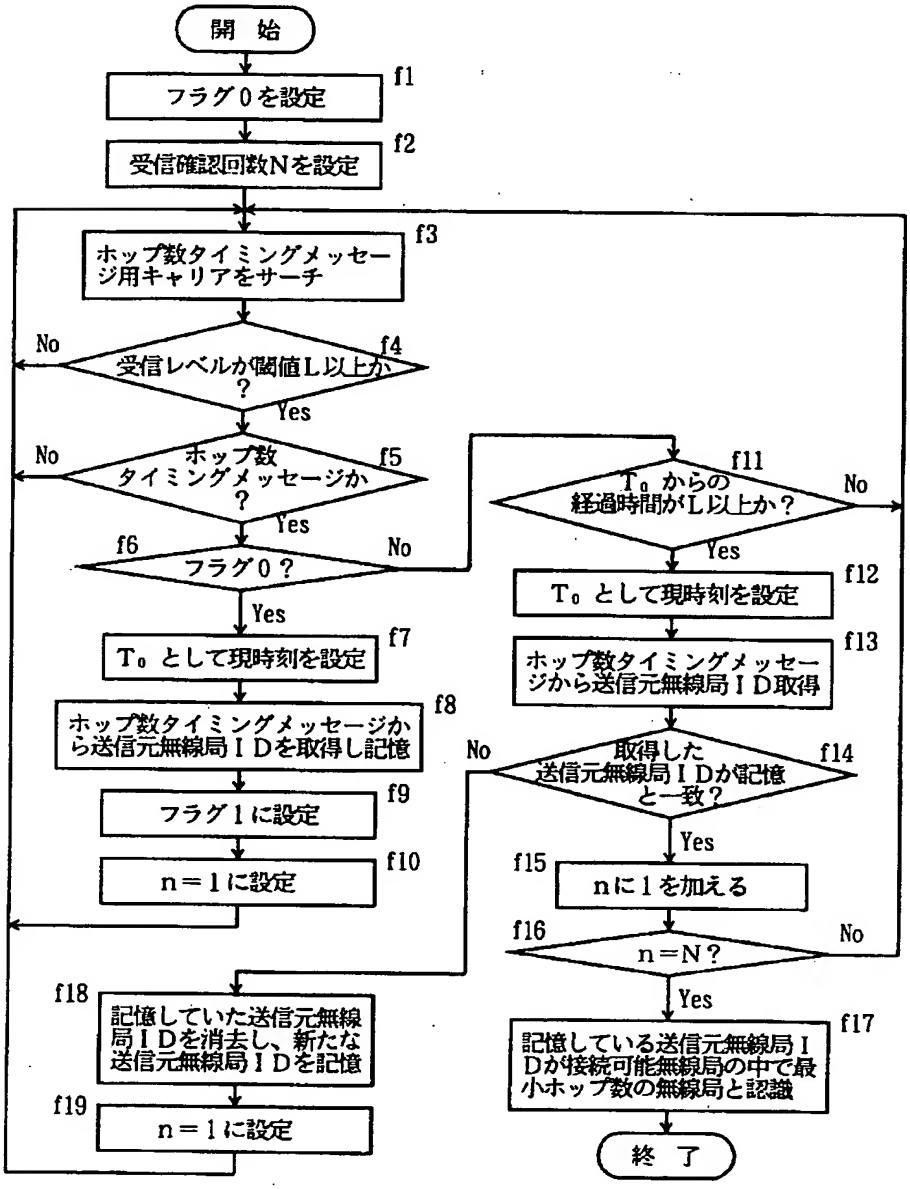
【図８】

基地局および各無線局のホップ数タイミングメッセージを送信するタイミングの一例



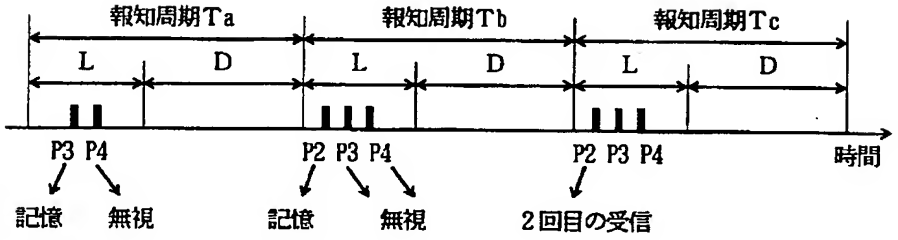
【図９】

ホップ数情報取得手段11および上位接続先無線局選定手段12の処理手順の第２の実施形態



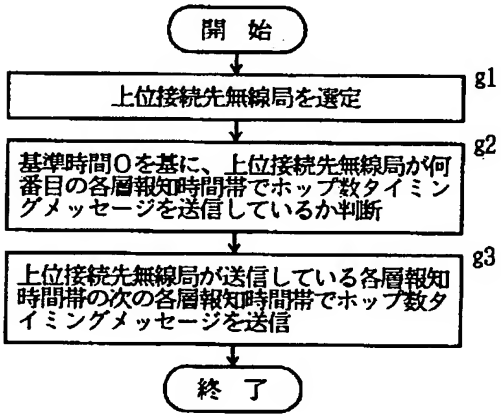
【図１０】

第２の実施形態の具体的な動作例



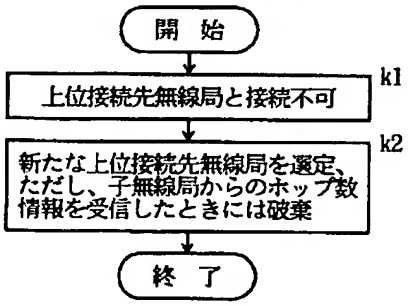
【図１１】

第２の実施形態におけるホップ数情報の送信処理手順



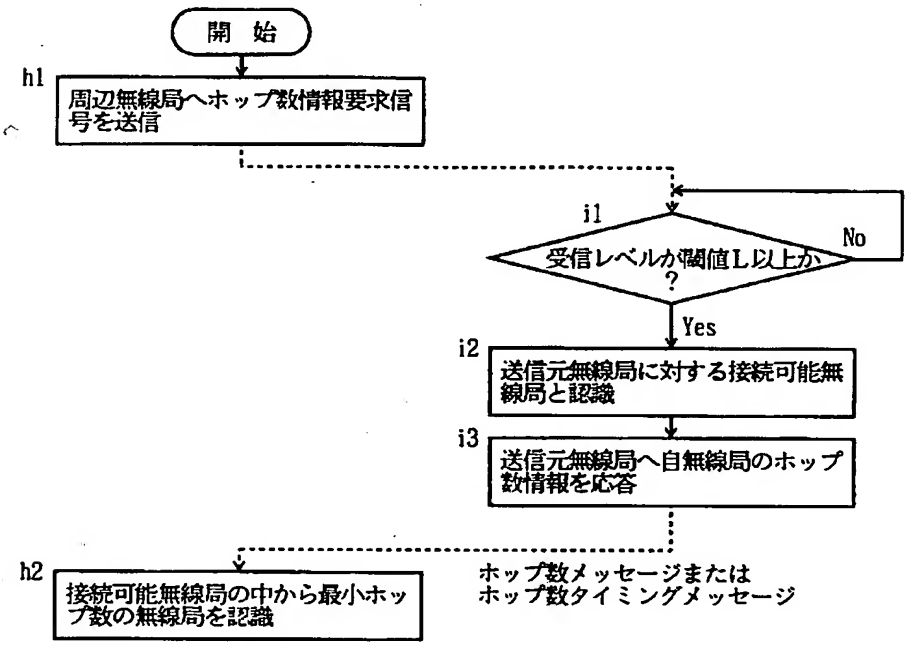
【図１４】

ホップ数情報取得手段11および上位接続先無線局選定手段12の処理手順の第５の実施形態



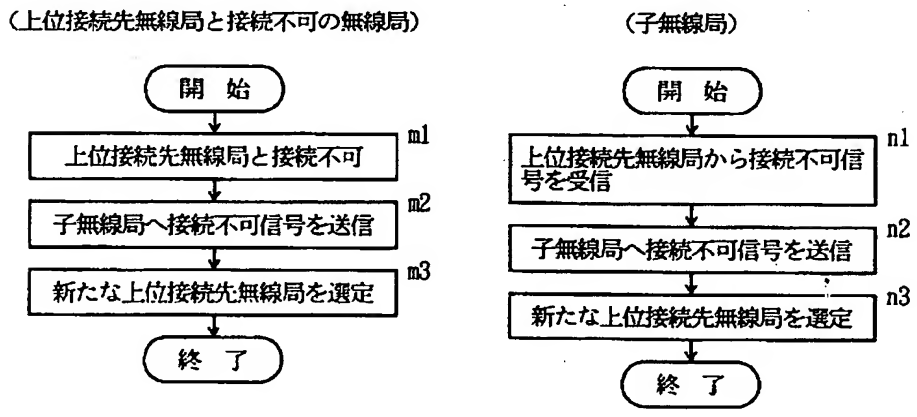
【図１２】

ホップ数情報取得手段11および上位接続先無線局選定手段12の処理手順の第３の実施形態



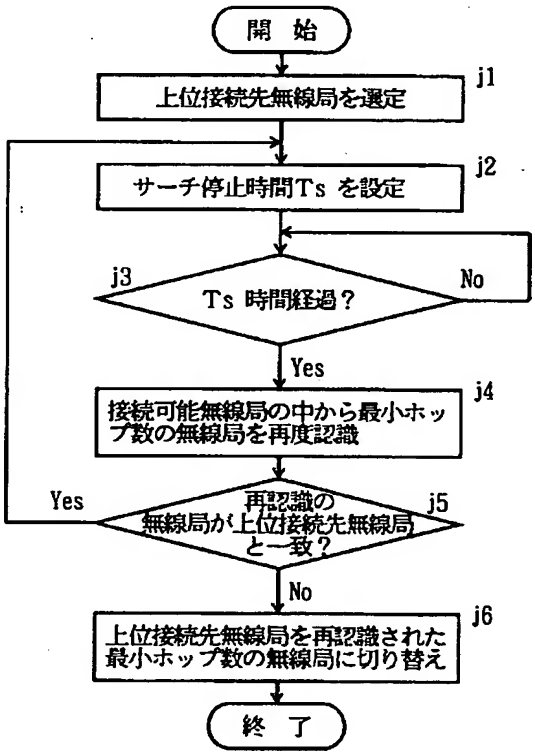
【図１５】

ホップ数情報取得手段11および上位接続先無線局選定手段12の処理手順の第６の実施形態



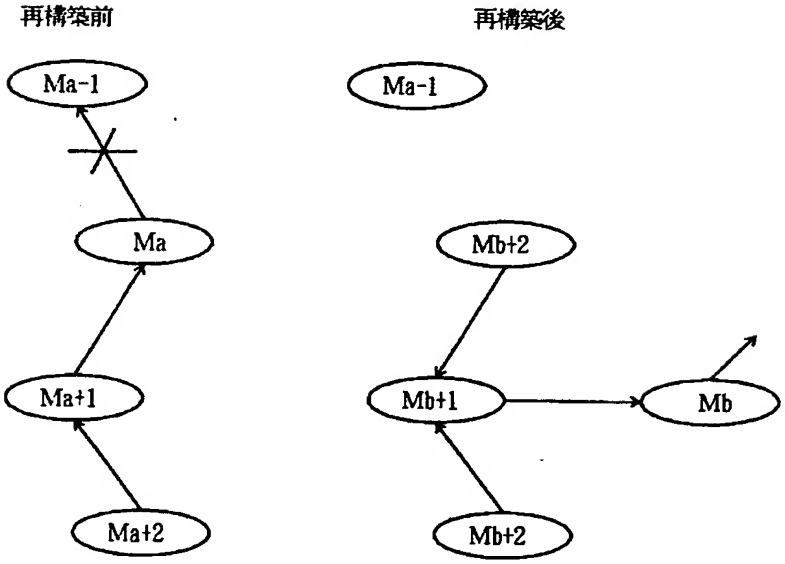
【図１３】

ホップ数情報取得手段11および上位接続先無線局選定手段12の処理手順の第４の実施形態



【図１６】

第６の実施形態の具体的な動作例



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